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THE PREDETERMINATION OF THE PROPER SIZE OF RAILWAY FEEDERS

Too frequently those in charge of electric railways rarely give a thought to the size of feeders that will give them the greatest economy, but allow the copper in service to carry the load until the line voltage cannot be kept up with the highest pressure the generators will give. Then more copper is added, and the process continued, except on such long lines that the cost becomes prohibitive, where boosters are added and a new starting point is obtained for the same elementary substitute for calculation. There may be found on other pages of this issue a paper by Mr. G. F. Greenwood on the new power station of the Consolidated Traction Company of Pittsburg. One of the interesting features of this installation is the use of 1100 volts and an Edison three-wire system. Even with this doubling of the voltage and consequent reduction in the needed copper, the calculation of the feeder system has been carried out with unusual thoroughness. The various elements of the total cost of the feeders and of the power lost in them are plotted as shown in the illustration for various percentages of power, and the minimum point on the curve representing the total outlay is found. The components of the expense which this curve represents are, first, the cost of the feeders—which are assumed to be underground—costing $1645 per mile of 500,000-c. m. cable. Interest and depreciation on this is figured at 12½ per cent. In addition to this, there is lost in the feeders a certain amount of power which requires an increase in the power-house investment to supply it. This increase in the power-house investment is figured at $40 per horse-power, and the interest and depreciation upon it is figured at 10 per cent. Over and above this fixed charge on the machinery generating it, the power wasted in the feeders is estimated to cost $36.50 per horse-power-year, this cost being solely that of fuel, attendance, supplies, etc., generally comprehended in the term operating expenses. It is figured at one-half cent per horse-power-hour, amounting to $36.50 per horse-power-year, twenty hours' daily operation being assumed and all figures being for average load.

The value of the wasted power and the increase in the power-house investment is proportional to the loss in the line, while the investment in copper is inversely proportional thereto. The sum of the charges on the two or the whole expense of the feeder is the outlay which should be brought to a minimum. This outlay can be varied greatly by changing the amount of copper, and a minimum found, for the reason that with more than the proper amount of copper the saving in the power wasted in the line is less than the increase in the interest and depreciation on the copper, while with less copper the wasted power in the line increases more rapidly than the interest and depreciation diminish. This minimum was found under the conditions assumed at about a 10-per cent. drop, a figure commonly accepted as a proper basis in railway work. This was for a feed of 14,000 feet at 1100 volts bus-bar pressure, so that the same best percentage drop would be found on 550-volt systems at one-quarter of that distance, or 3500 feet.

THE "PUMPING" OF ALTERNATING-CURRENT MACHINERY.

One of the most perplexing and bewildering difficulties to those designing as well as to those operating alternating-current plants is that peculiar action of the machines variously termed "hunting," "beating," and "pumping." With two or more synchronous machines (either generators or motors) running in multiple with each

other there is likely to be superposed upon the synchronous rotation of the several machines a pendular oscillation constituting an alternate acceleration and retardation. This, in many cases, becomes so violent as to utterly destroy all voltage regulation, if not to absolutely throw the machines out of synchronism. The exact cause and nature of these oscillations is as yet little understood and no good means of overcoming them has up to the present been developed in this country.

This oscillatory action, of course, is dampened by the connection of the machines mechanically to driving or driven powers that sluggishly resist changes of speed. For instance, two generators, belt-driven from the same countershaft, are not likely to and rarely do "pump," owing, undoubtedly, to the fact that if one tends temporarily to speed up even slightly it causes a great variation in the belt slip, which reduces the power transmitted to it, and vice versa, thus checking the tendency. As great a check does not exist with machines coupled to independent prime movers, the speed of which can be varied—in oscillations so quick that the governor cannot follow them—with no great change of torque. The same differences may be found between the loads carried by synchronous motors. Some loads, such, for example, as an air compressor, yield without resistance to changes of speed, while others, which may be typified by centrifugal pumps, resist strongly any change of velocity. There is one synchronous machine in which there is absolutely no resistance to the pumping and with which the greatest difficulty is experienced, and that is the rotary converter. For reasons that will appear below the oscillations of its speed due to this cause do not affect the voltage of the direct-current end of the machine, and therefore the load exerts no braking action on the pumping.

The disturbance is generally started, and is always seriously affected, by any irregularities in the driving powers or the driven loads. For this reason it is closely dependent upon the variations of the torque of steam engines as the crank passes through its double cycle of minimum and maximum effort per rotation. By the beats of the ammeters in the supply of synchronous machines taking power from steam-driven systems the number of turns of the engines can readily be counted, often even if the latter have two or more cranks or there are several of them in multiple. Engines, therefore, for driving alternators in multiple must be much more carefully designed than for driving railway generators in multiple. The uniformity of rotation is so important that recent specifications have called for a maximum variation of the angular position from the mean position of absolute uniformity of rotation of a small fraction of one degree. This requires extremely heavy fly-wheels. From the fact that the pumping is in time with the engine strokes many have obtained the idea that it does not exist with turbine-driven plants, but unfortunately it does, and often to a distressing extent.

The pumping has been found to be accompanied by a shifting of the lines of force across the pole-faces from horn to horn, as the machine oscillates. Apparently there is no electro-mechanical exchange of energy—that is, as one machine slows down the kinetic energy of motion of its rotor is not stored up magnetically or electrically at any point, but is given to another machine, which simultaneously speeds up, the two pulling each other back and forth, as it were, as though connected by an elastic and highly resilient belt, which the electrical circuit in certain cases seems to become. This shifting of the field flux across the pole-faces suggests at once a means of damping which has been tried after a fashion in this country and more thoroughly in France, and that is the use of short-circuited coils or windings to choke it by a foucault-current action. One of the first cures attempted in this country was the use of a copper strap around the pole, but as the pumping is not accompanied by any material variation of the total field flux this had little effect. The self-induction of the field winding itself would, in fact, check variations of the field magnetism almost as well as any short-circuited strap. Copper straps have been inserted under the horns with not much more success. In a recent communication to La Société Internationale des Electriciens, M. Maurice Leblanc describes a means used in France, and there found successful. It consists of a short-circuited bar winding, constituting a "squirrel cage" exactly like that of an induction motor, the bars threaded through the pole-pieces of the alternating-current machines (generators or motors) as closely as possible to the air gap and riveted into straps, not embracing only those bars in one pole-piece, but running around the whole machine. The squirrel cage is made of ample proportions, with a cross-section of copper fully equal to that in the armature conductors at the other side of the air gap, and the pole-shoes are extended until the horns almost touch. He states that with this modification, single-phase, 40-cycle fly-wheel alternators of 600-kw capacity direct-coupled to single-cylinder horizontal engines turning at only 60 r. p. m. have been successfully run in multiple with each other. In another case two 250-kw machines are purposely synchronized with the cranks of their respective single-cylinder engines at right angles to each other, so that the effect of a two-crank engine is obtained. This is a remarkable result, as experience generally has proven the necessity of synchronizing such machines with their cranks parallel.

In the selection from types now on the market, to avoid trouble from hunting certain precautions may be observed. Machines built for close regulation undoubtedly give less trouble in this respect than those with a high armature reaction, for, although the hunting may exchange as much power between the machines in one case as in the other, that with the more powerful field is less liable to "flop over" and lose synchronism, an accident which is anything but pleasant in the case of converters. Solid poles also give a certain immunity, the conducting qualities of the iron acting to give a foucault-current shield. Low frequencies are less troublesome than high owing to the fact that the lower the frequencies the smaller is the number of cycles per stroke of the engine and the lower is the ratio of angular deviation to the pole angle. Two machines of the same size are more likely to pump together than two of very different sizes, probably because the smaller cannot oscillate the larger. One machine of a size much larger than several others seems, in fact, to steady the latter. For example, there is practically no trouble from pumping on the Niagara system. Installations wherein there are converters of approximately the same size as the generators are particularly troublesome, even more so than where there are several converters running side by side. The immediate connection of machines in this way seems to be less troublesome than a connection less direct. In one instance known to the writer two converters running side by side operate all right, but either one will pump with another of exactly the same size running on the same transmission circuit 10 miles away. The self-induction of the lines and transformers between the machines in this case seems to give a springy effect that increases the amplitude of the oscillations. The pumping is also much worse with a unity power factor than with heavy wattless currents, and may often be eliminated by so varying the field excitations as to give the latter. Induction machines, of course, are not subject in the slightest degree to this difficulty.

The Proposed German-American Cable.

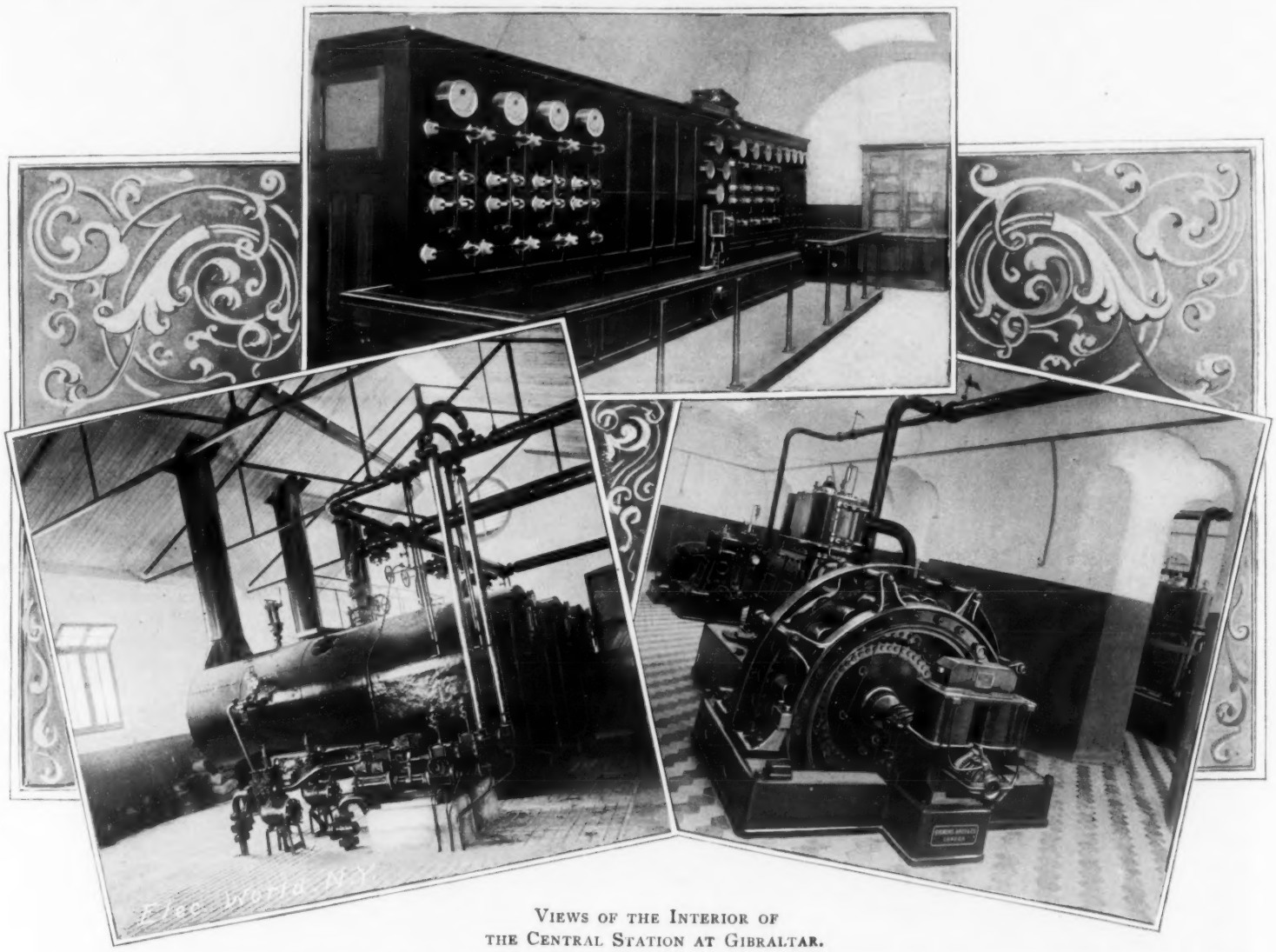
Foreign papers report that a company, with a capital of one million pounds, has been formed to lay the proposed direct cable between Germany and America, and that the cable will be made by Messrs. Felten & Guilleaume.

The Electric Lighting of Gibraltar.

THE Colonial Department of the British Government has established electric lighting plants in many of its crown settlements, the latest of these being that at Gibraltar, which was put into operation for the first time on Christmas Day, 1898. This installation (which is described in the London "Electrician," from which the following data and illustrations have been taken) partakes naturally of the solidity and massiveness characteristic of the whole governmental establishment at Gibraltar, and is apparently intended to imitate in the matter of depreciation so far as possible the enduring nature of the rock itself.

The plant is erected partly in four arched casemates of what is known as the King's Bastion, which is one of the best protected spots on the rock. The main generating units stand in two of these casemates, the third containing the condensing apparatus, with room for a fourth generator, and the fourth the switchboard. The boilers stand in a structure immediately outside, and are, as the illustration shows, three in number, of the locomotive type, worked at 150 pounds pressure and capable of evaporating about 2000 pounds of water each per hour. The plant is surface condensing, with sea water circulation, and feed water is obtained from rain water catchments. For use in case these should fail there is provided an evaporator, in which live steam vaporizes sea water, which is then passed into the condenser, thus distilling fresh from the salt water. There are four generating sets—two rated at 100 kilowatts each, one 50 and one 25 kilowatts. They are all direct-coupled machines, consisting of Belliss enclosed high-speed two-crank vertical engines coupled to Siemens single-phase alternators. The machines are run at a high speed, the largest making 380 revolutions per minute, the generators giving 73 cycles per second at a pressure of 2000 volts. Each is fitted with its own bipolar exciter direct coupled to the end of the main shaft.

The switchboard, which is illustrated herewith, possesses several features to excite the curiosity of American engineers. Its panels are of enameled slate, the four in the immediate foreground being feeder panels, that in the centre the instrument panel, the next four main generator panels, and those at the further end exciter panels. The switch clips are buried in porcelain sheathes, the knives of the switches being horizontal instead of vertical and connected laterally through porcelain tubes. Long, horizontal enclosed fuses are also slipped into similar clips above and below the main switches. On the instrument panel at the centre of the board is a totalizing ammeter and integrating wattmeter carrying the whole load, and the voltmeters and synchronizing lamp. The latter is connected up with the secondaries of two transformers in series with each other in the ordinary way, the primary of one being straight across the one set of single-phase bus bars, and that of the other across a pair of synchronizer bus bars, which are connected up with receptacles on each generator panel, exactly as voltmeters are connected up in railway plants in this country. A four-contact plug serves to connect the synchronizing set between any machine and the bus bars.



VIEWS OF THE INTERIOR OF
THE CENTRAL STATION AT GIBRALTAR.

A voltmeter connected across the synchronizer buses allows the voltage of any machine to be compared with that of those running on the mains, as indicated on the instruments connected across the main buses. The voltmeters are all electrostatic.

Four concentric feeders, two of them constituting a high-tension ring main, radiate to the five transformer substations which

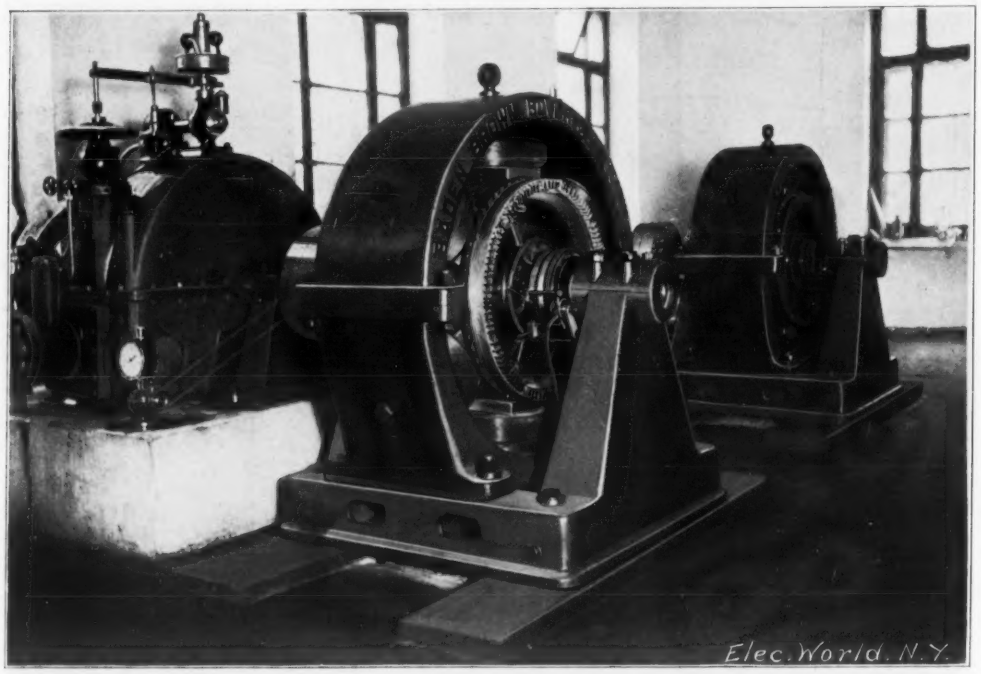
feed the distributing networks. The concentric cables are insulated by bitumenized fibre, lead sheathed, yarned, armored by two steel tapes, and, finally again, yarned and compounded. With all this wrapping they may naturally be laid in the ground without protecting ducts, and are so run, generally under the footpaths. The low-tension network for the supply of buildings is run at 110 volts with two-wire concentric cables, there being, in addition, a separate network run from the substations with 220-volt vulcanized bitumen three-wire cables solely for the street lighting. This is effected by means of 8, 16 and 32-cp incandescent lamps, at present some 500 in number, arranged singly or in groups in lanterns and carried on ornamental brackets attached to the walls of buildings, or, in a few cases, on posts. Alternate lanterns are connected to opposite sides of the three-wire system so that by opening one of the outers at the substations one-half the street lighting may be cut off, as is done after midnight.

The substations are excavations below the ground level, fitted with ten and twenty kilowatt transformers for feeding the 110-volt mains and separate transformers for the three-wire street lighting system. The cables run into the transformers through heavy boxes containing the high-tension switches and fuses, similar boxes being fitted between the transformers and the low-tension mains. There are no instruments, and everything is so carefully enclosed that dryness is not essential in the substation.

Train on Twenty-five Per Cent. Grade.

The Stansstad-Engelberg Three-Phase Electric Railway.

It is somewhat of a paradox that mountain railroads with excessive gradients, sharp curves, etc., should be the first to use induction motors, against which the chief objections cited have been their inability to carry heavy overloads, poor starting torque and great weight per horse-power output. The third three-phase railroad to be opened for traffic during the last year is that running from Stansstad, on the Lake of Lucerne, to Engelberg, a tourist resort, fourteen miles from the lake as the road runs, and at an elevation 1873 feet above it. A description of the electrical equipment of the road is given in a recent issue of the London "Electrician," from which the following facts and illustrations have been taken.

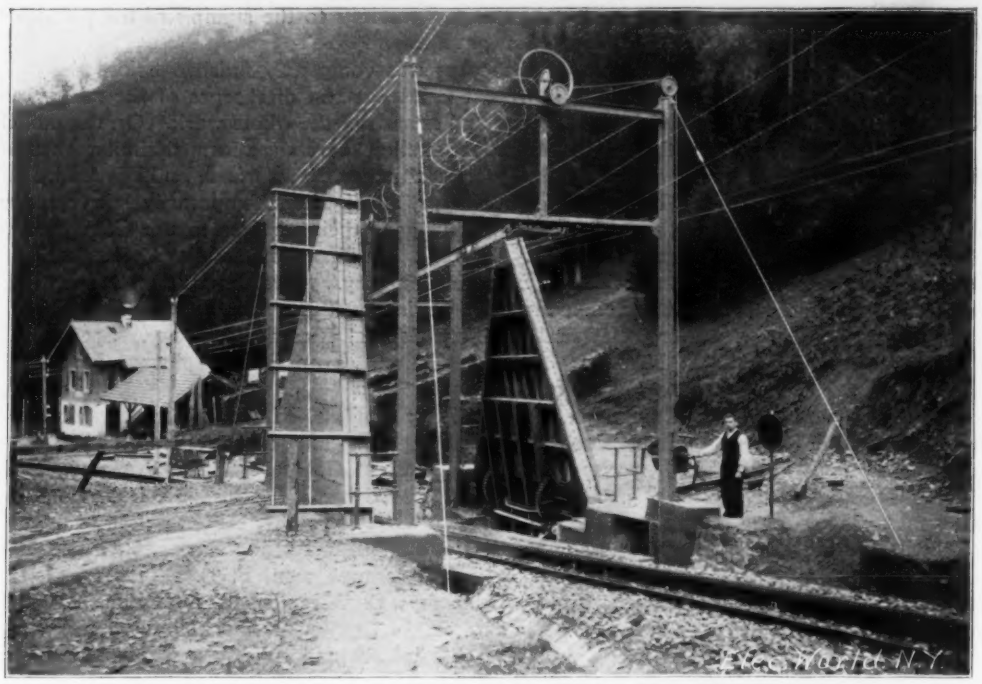


Three-Phase Generator and High-Pressure Turbines at the Obermatt Power Station.

The power is derived from a hydraulic plant on the line of the road and exceptionally favorably situated, being at the foot of the heaviest grade, requiring the greatest amount of energy. The water is used under an available head of 1280 feet, being collected from a series of small springs which fill a reservoir, from which it is carried to the power house through a 12-inch pipe line about a mile in length. The generators are driven by Pelton wheels controlled by hydraulic governors. The wheels are rated at 200 horse power each at 650 r. p. m. and are direct coupled to the generators. The latter are three-phase revolving-armature six-pole machines, built by Messrs. Brown, Boveri & Co., and generate current at 750 volts with 32.5 cycles per second. Their fields are supplied by independently driven exciters. The line is fed at machine pressure, the distant end being supplied by means of a high-tension transmission line worked at 5000 volts and fed from three 30-kw single-phase step-up transformers in the power house, the current being stepped down again in the substation seven miles away by a similar group. The power station is also fitted with a water rheostat consisting of three rails laid under water in the tail race and connected with the three legs of the circuit. The motors on the cars are used as generators to control the speed in descending the heavy grades, and this water rheostat is thrown in when the power so generated exceeds that used by other cars absorbing power.

Another detail of interest in the power house is an automatic circuit-controlling device which cuts off the power in case any one of the three wires carrying the high-tension or 5000-volt current becomes grounded. It consists simply of three step-down transformers with their primaries Y-connected to the high-tension wires, the common point of the Y group being grounded. The secondaries of these transformers are delta-connected, there being cut into the delta the striking magnet of an ordinary arc lamp. As long as there is no ground on the high-tension system the electromotive forces in the three sides of the delta at all instants balance each other, but in case of a ground an unbalanced force exists, which generates a current and lifts apart the carbons of the arc through which passes the 110-volt exciting current of the generators. The latter then dies down in a few seconds' time, the arc being used instead of a circuit breaker in order to diminish the inductive rise

of voltage in the fields. The line is single-track laid with T rails to metre gauge, on 66-pound steel sleepers, spaced about 36 inches apart, centre to centre. The rails are bonded to form a track return. A short section, about one mile in length, is fitted with a rack rail, the grades on this section varying from 8 to 25 per cent., the maximum grade where frictional adhesion is depended upon for traction being 5 per cent. The rack rail is of the so-called ladder type, consisting of two parallel girders of rolled steel, between which cylindrical teeth are riveted. Its ends are spring-supported and depressible, so that the pinions on cars running onto it may adjust themselves to the teeth without breakage.



VIEW SHOWING THE DRAWBRIDGE AT GRUNEWALD OPEN.

The two overhead trolley wires are of hard-drawn copper 0.3 of an inch in diameter and run 3 feet 2 inches apart, being span-suspended from wooden poles. The high-tension wires are carried on a separate pole line beside the track. The poles of this line are carefully guyed to prevent their falling over the track, and at all crossings with any other wires the various lines are surrounded by wide-mesh nettings, as some of the accompanying illustrations show.

The rolling stock consists of five motor cars and two locomotives. The former are mounted on double trucks, the bodies being 46 feet in length and weighing 14 tons. They are equipped with the several compartments characteristic of European railway coaches, and are driven by two 35-hp induction motors weighing one ton each, both mounted on one truck and connected with the wheels through the standard American single-reduction gear with Sprague suspension. The other truck carries a pinion, which engages with the rack on the steep incline, and is fitted with a powerful hand brake, besides which is the regular hand brake on the eight wheels. The induction motors have wound secondaries fitted with collector rings, which are connected by carbon brushes to rheostats by which the driver may temporarily increase the secondary resistance for starting, the rest of the controlling equipment consisting simply of a reversing switch in the primary circuit. The car runs thus normally very close to a given speed whatever the load and whether it is going up or down grade. This normal speed, above which the motors act as generators tending to brake the car, is 12½ miles per hour, the motor armatures making 480 r. p. m.

These motors are insufficient to drive the cars up the heavy grades on which the rack is used, and here the car is pushed up by a locomotive. This small single-truck machine resembles closely that used on the Jungfrau railway.* It weighs about twelve tons and is fitted with two 75-hp induction motors, both geared to a common intermediate shaft, which in turn is geared to the driving pinion running in the rack, giving a double reduction of 15 to 1, driving the machine at about 3.1 miles per hour. The intermediate shaft is also fitted with friction clutches, by which its connection to the rack pinion may be loosened, and it may be connected with another pinion concentric therewith, driving two crank discs connected with the four wheels of the locomotive by parallel rods. The gear ratio for this driving by means of frictional adhesion differs from that of the rack gearing and gives a speed of about 7½ miles per hour. Of course when the locomotive is driving the motor car the motors of the latter are thrown out of service.

The locomotives are fitted with three independent methods of braking: first, the ordinary brake shoes on the wheels; second, the use of the motors as generators, which is automatically accomplished whenever the speed exceeds synchronism, and third, an emergency brake operating on grooved drums on the gear train. The latter is fitted with a gravity device, which sets it when released by a trigger operated by a centrifugal speed limit. Current is collected from the two overhead wires by means of two sliding bow trolleys to each car, each bow consisting of two cylinders of aluminum, one for each leg of the overhead circuit and separated by a piece of wood soaked in paraffin.

CROSSING OF RAILWAY BY THE STANSSTAD-STANS TRAMWAY.

The Nernst Incandescent Lamp.

Cable reports from London state that the presentation of the Nernst lamp before the Society of Arts on the evening of February 8 created a sensation among the members. Messrs. Swinburne and Ayrton are alleged to have declared it to be the greatest discovery in many years.

*See THE ELECTRICAL WORLD, October 15, 1898.

Electric Light Men in the War.

It is a fact probably not generally known that the first completely organized body of men to volunteer their services to the Government in the recent war with Spain was composed entirely of men engaged in electrical pursuits.

The Boston Battalion of the Volunteer Electrical Corps was the first organization of any kind to have a complete roster on file at the War Department. On March 26, 1898, the services of the corps were accepted by the War Department officials, conditional upon its need in the event of hostilities. The inception of the idea was brought about by the visit of one of the United States engineering officers, Lieutenant (now Colonel) Sewell, to the Boston office of the General Electric Company for the purpose of purchasing cable in the early part of March.

While engaged in conversation with Mr. Caryl D. Haskins, of that company, whom he had known as an authority on torpedoes, it was suggested by Mr. Haskins that the assistance of the electricians in the event of hostilities would be most valuable. Colonel Sewell agreed instantly and enthusiastically.

Mr. Haskins at once set to work and laid a plan of organization before General Griffin, first vice-president of the General Electric Company, which resulted in his approval and the subsequent temporary organization of the Civilian Auxiliary Engineering Corps, 162 men and officers pledging themselves to the cause; only about one-third of these men were connected with the General Electric Company. About ten days later, March 26, General Griffin and Mr. Haskins went to Washington, visiting the Government departments, which resulted in the formal acceptance of the Volunteer Electrical Corps conditional upon need of its service. One of the principal reasons of its acceptance was because of the fact that the United States Government had at the time only about 400 engineering troops and 120 engineering officers in the regular army, a force utterly insufficient to do the enormous amount of work necessary for the proper mine defenses of the different harbors of the country. On Mr. Haskins' return to Boston a call system, telegraphic and telephonic, was adopted whereby all the members could be called together on two hours' notice. The officers of the corps immediately received instructions from the regular engineering officers in mining, military communication and range-finder work. April 5 they unexpectedly received orders from Washington to report at the office of the District Engineers in the evening for instructions, and in the morning two squads of the first division were called into active service. Within one week thereafter the entire corps was actively engaged. The corps laid all the mine defenses in Boston Harbor, handling about 100,000 pounds of high explosives. About 25 miles of cable were used in establishing complete range-finder communication between different points in the harbor, this part being done as emergency work on behalf of the United States Signal Corps. The corps was assisted in the loading of the mines by five regular army engineers, and about twenty laborers were employed, working under the direction of the corps' officers. Complete electric light plants for the illumination of the forts and for supply current to searchlights were installed at Fort Warren and Long Island Head. These plants were in operation before a roof could be provided for them, which shows the rapidity with which the apparatus was gotten together. The searchlights were mounted on a novel and very efficient form of disappearing carriage invented and designed by Mr. F. M. Kimball. Owing to the scarcity of armored cable at this time the officers of the corps took personal responsibility in putting down unarmored cable between points where submarine communication was necessary; about two miles of special heavily insulated multiple telephone cable was used. It was provided with an extra heavy rubber insulation and a very thick woven outer covering. It is an interesting fact that this cable stood up and did its work until the day previous to the signing of the protocol, when the insulation gave way.

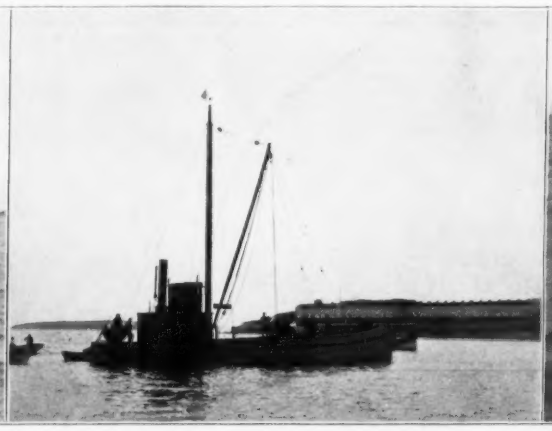
The work of the corps was completely finished before the first of July, and the recent numerous test discharges of the mines has proved the efficiency and success of the whole work. On the model of the original Boston Battalion there were formed similar ones in New York, Philadelphia, Baltimore, New Orleans and Portland, Me.

The officers of the corps, all of whom temporarily left lucrative positions and patriotically gave their services to the Government, were as follows: Caryl D. Haskins, commanding, electrical engineer General Electric Company. First executive officer, Dr. Louis Bell, consulting engineer. Second executive officer, S. B. Paine, electrical engineer General Electric Company. Special aid, E. H. Hoyt, chairman Committee on Street Railways Massachusetts Legislature.

Commanders of divisions: 1. H. S. Kimball, electrical engineer Edison Electric Illuminating Company, of Boston; 2. F. M. Kimball, manager supply department General Electric Company, Boston; 3. A. B. Bush, succeeded by C. B. Burleigh, both electrical engineers General Electric Company; 4. J. H. Grant, steam expert.

Officers commanding squads: A. Telephone men, R. Fiske, Bell Telephone Company; B. Telegraph men, F. E. D'Hussey, of the Postal Telegraph Company; C. Wiremen, T. D. Drive, electrical engineer; D. Wiremen, F. L. Barnes, president Godfrey Construction Company; E. Cable joiners and splicers and linemen, L. L. Elden, electrical engineer Boston Electric Light Company; F. Electricians and wiremen, C. N. Whitney, General Electric Company; G. Electricians and wiremen, J. Ahearn, General Electric Company; H. Electricians and wiremen, George N. Dow, General Electric Company; I. Expert electricians, F. P. Cox, succeeded by F. G. Vaughan, General Electric Company; J. Expert electricians, H. W. Brown, General Electric Company; K. Expert electricians, E. F. Dutton, General Electric Company; L. Inside wiremen, H. Bottomly, manager Marlboro Electric Company.

Running Range-Finder and Position-Finder Cables.



Mine Planting.

Laying Mine Cables.

Synchronizing Alternators.

A rough-and-ready method of indicating synchronism to engine drivers so that they may—independently of the switchboard attendant—adjust the speed of a machine to be synchronized, is, according to the London "Electrical Engineer," in use at the Wakefield Electricity Works. The station is lighted by alternating-current arc lamps supplied from the bus bars, a number of bolt heads on the engine fly wheel corresponding with the number of poles being painted white. The intermittent light of the arc lamps shows these up more or less after the method of a stroboscope, so that at synchronism they appear to stand still. With the machine running below synchronism they appear to move backward slowly, and above synchronism to move forward slowly, giving the engine attendant a sufficiently accurate indication for his manipulation of the throttle valve and governor.

UNIVERSITY

Proposed Water Power Development at Shawinigan Falls, Province of Quebec, Canada.

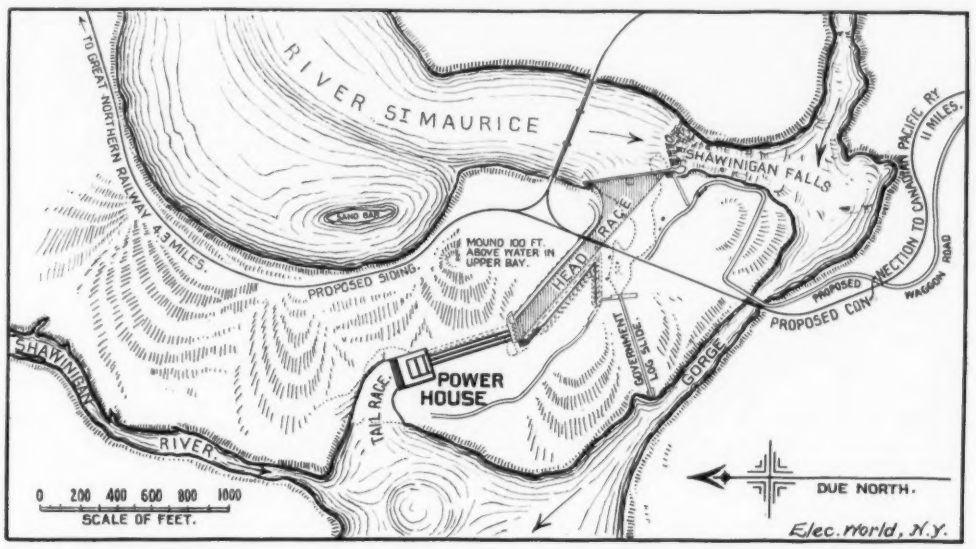
A water power development of rather unusual interest, the construction of which will soon be commenced, is that of the Shawinigan Falls, on the St. Maurice River, P. Q. This power and over 800 acres of land adjacent thereto are owned and will be developed by the Shawinigan Water and Power Company, of Montreal.

At these falls the river, which is one of the largest in Canada, draining some 18,000 square miles of territory, drops over 140 feet in a very short distance. The extraordinary formation of the peninsula of land lying between the upper and lower levels of the river above and below the falls, and the way in which the river turns at more than a right angle to its course after hurling itself down the main cascade, here affords what is undoubtedly one of the most favorable natural locations for a water power development in the world.

Owing to the nature of the country drained, which is densely wooded throughout, the flow of water in this stream is very steady throughout the year. At lowest water it is calculated that sufficient water passes over the falls to develop 190,000 horse-power, under the working head of 120 feet, on the shafts of turbines having 80 per cent. efficiency. Of this amount 150,000 horse-power could safely be used.

The falls are very favorably situated as regards access to rail and water shipping facilities. The Great Northern Railway, which is a link in the short line route from Chicago and Parry Sound to Quebec by way of Ottawa, passes close to the falls, and the construction of a siding 4½ miles long to this road will be commenced in the early spring. This will give communication with Quebec 90 miles distant in one direction and with the great West by the shortest known route in the other direction. The Canadian Pacific Railway, Canada's transcontinental line, passes within 10 miles of the falls on the opposite side of the river, and a siding from this road has been located by the engineers. The operation of the Montreal and Quebec division of the Canadian Pacific Railway and a considerable section of the Great Northern Railway by electricity, using either the trolley or the third-rail system, is claimed by the engineers to be well within the commercial possibilities of this development.

Three Rivers, a town of 9000 inhabitants, at the junction of the St. Maurice River with the St. Lawrence River, and 17 miles distant from the falls, is a seaport with excellent shipping facilities, which afford means of water communication with the ocean and the great lakes for eight months in the year. The Canadian Pacific Railway passes through this town, and the Grand Trunk Railway is reached by means of a ferry to the opposite shore of the River St. Lawrence. It is intended to transmit power under 20,000 volts pressure to this town for manufactures of various kinds on an extensive scale.



MAP SHOWING THE NATURAL ADAPTATION FOR HYDRAULIC DEVELOPMENT AT SHAWINIGAN FALLS.

The present development, for which contracts have been let, and on which construction will be commenced shortly, will consist of the installation of turbines and generators for 30,000 horse-power, with provision for extension up to 150,000 horse-power. Twenty thousand horse-power of this will be in the form of alternating current for transmission to Three Rivers, and 10,000 horse-power in low-voltage direct current, to be used in various electro-chemical industries in the vicinity of the falls. The water is to be taken in from the side of the river just at the head of the falls, and carried back in a head-race 1200 feet long, 100 feet wide and 16 feet deep. The arrangement of the head-race entrance will naturally tend to allow the draft over the falls to carry off the frazil and anchor ice which is such a bugbear to all engineers who have to deal with water powers in Canada.

The bulkhead is to be of concrete, with steel grates operated by pneumatic pressure, in front of feeder-pipe inlets, and from here the water will be carried down in steel feeder pipes 13 feet in diameter and about 550 feet long. Each of these pipes will carry sufficient water to develop 10,000 horse-power net, under the working head of 120 feet. Two of the pipes will be connected to two pairs of twin turbines, each of 5000-hp capacity, running at 300 revolutions per minute, each direct connected to an alternating-current 5000-hp generator. These generators will be among the largest horizontal shaft generators yet built, and will weigh in the neighborhood of 100 tons. A pair of gate valves 78 inches in diameter, with pneumatic lift, will control each unit of 5000 horse-power, so that should one unit require to be stopped, the opposite one on the same pipe can be kept running. The turbines operating the direct-current generators will consist of four pairs of twin turbines, each of 2500-hp capacity, having two direct-connected generators, one on each end of the driving shaft. Each of these 2500-hp units will also be controlled by separate gate valves.

A special feeder pipe 4 feet in diameter will run the exciters and the air compressor, supplying air for the operation of gate valves, switches, etc. All the feeder pipes are to be coned down and provided with numerous pop valves and large air cushion cylinders to relieve water hammer. The governors will be operated by compressed air, and in operating the cylinder gates of turbines a novel arrangement has been devised, so that no moving part of the mechanism will operate under water. Roomy tunnels well above back-water level will run between the generators and switchboards and transformers. The switches will be operated by compressed air, and the switchboard is so located as to overlook all the generators and exciters.

The transmission lines to Three Rivers, operating under a pressure of 20,000 volts, will be two in number, one on each side of the river, so as to avoid the risk of total loss of line from forest fires which might occur in the wooded country through which the lines will pass. These lines will be 17 miles long, of which 15 miles will be dead straight. Wire will be bare copper on triple petticoated insulators set on suitable cross arms on heavy cedar poles set 6 feet into ground, 100 feet apart.

A triple line of lightning arrestor wires, grounded at every fourth pole, will be carried over the transmission lines. The transformers at both ends will be oil-filled self-cooling.

Messrs. T. Pringle & Son, of Montreal, are the company's engineers for both the hydraulic and electrical development, W. C. Johnson, engineer of the Niagara Falls Hydraulic Power & Manufacturing Company, being consulting engineer. Wm. Israel Bishop will be engineer in charge, and F. H. Leonard will have charge of the designing and installation of electrical apparatus.

For a Cable to the Philippines.

On Friday, February 10, President McKinley sent to Congress a message calling attention to the need of a trans-Pacific cable via the Hawaiian Islands and Guam to Manila, and pointing out the fact that deep-sea soundings must be taken west of the Hawaiian Islands, and, owing to the magnitude of the work, it will require at least two years after work is commenced to construct it. For these reasons the President suggests that the subject be given immediate attention and receive prompt action.

The Hysteresis Errors of Electricity Meters Containing Soft Iron Armatures.

BY PROF. WILBUR M. STINE.

The accurate study of the effect of hysteresis in the soft iron armatures of certain types of electricity meters requires a source of e. m. f. which may be varied continuously between initial and final values. This condition has been fully met by an apparatus which was designed by the writer in 1894, and named, from its action, a variable-potential rheostat.

The aim in its design was to obtain an apparatus which should readily and absolutely furnish any desired difference of potential within the working limits employed. The principle selected was that of the slide-wire resistance. The old and familiar rheotome of Wheatstone, later modified and improved by Kelvin, served as the basis for the design. The essential modifications consist in employing two insulated cylinders, instead of one, and using the guide for the wire to take off the intermediate potential.

A number of incidental modifications have also been made. The accompanying illustration (Fig. 1) exhibits the completed apparatus. The two cylinders are bushed with hard rubber, and are 10 inches in length and 3 inches in diameter. One cylinder is fastened rigidly to the shaft; the other is loose on its shaft and driven by it through a spiral spring whose tension may be readily adjusted. This spring is necessary to compensate for temperature changes in the length of the resistance wire as well as to insure electrical contact with the guide-post by keeping a uniform tension upon it. A third shaft centred between the cylinders carries a hand-wheel and the driving gear, which meshes into gears of the same size on the cylinder shafts. The driving gear is of solid brass, while the cylinder gears are bored out and fastened to rubber insulating washers. Each shaft is mounted independently on a pair of standards, which in turn are bolted to rubber insulating plates. The entire apparatus is finally mounted on either a marble or wooden base.

The cylinders are accurately turned, and a light thread, pitch 36 to the inch, is cut on them. The centre shaft has a reverse thread of the same pitch cut on it. A split nut fitting on this shaft has an upwardly projecting post that serves as a guide for the resistance wire, and an electrical contact as well. The nut is prevented from turning by a downwardly projecting pin, working in a slotted guide. The resistance wire is fastened in place by screws passing into the brass cylinder heads, which complete the circuit between the outside terminals. The resistance wire has a length of nearly 260 feet and a diameter of 8 mils. It is of nickel alloy, and was furnished by the Weston Electrical Instrument Company. The resistance per foot of the wire is 3.21 ohms, and the total resistance of the apparatus between the binding posts A and C (Fig. 2) is 820 ohms. The carrying capacity of the wire permits the use of a maximum voltage of 250, and when it is desirable to employ a yet greater potential difference, a 5-mil wire of the same alloy is used.

THE METHOD OF USING THE RHEOSTAT.

The connections are clearly shown in Fig. 2. A suitable source of e. m. f. is connected to the binding posts A and C of the rheostat. The voltmeters—the standard Weston, W. V., and the one under test C. V., are attached to the binding posts A and B. The voltmeters will be acted upon by the potential difference between the contacts A and D, the contact D being varied at will.

THEORETICAL CONSIDERATIONS.

The class of apparatus here investigated consists essentially of a solenoid and a piece of soft iron pivoted at some point in the magnetic field of the solenoid. This is represented diagrammatically in Fig. 3. Suppose the soft iron armature to be situated on axis of solenoid and lying midway between its ends. The mean magnetic length of the armature is l centimetres, then when a current of I amperes is flowing through the n turns of the solenoid, the magnetic potential difference over the armature is, in gilberts,

$$\mathfrak{F} = \frac{4\pi n I}{10} \cdot \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But in many instances the soft iron armature is not placed in the geometrical centre of the deflecting coil; it is either pivoted eccentrically or placed at one end. For such cases the ratio of the magnetomotive force at the position of the armature to that at the geometrical centre will be expressed by the term p.

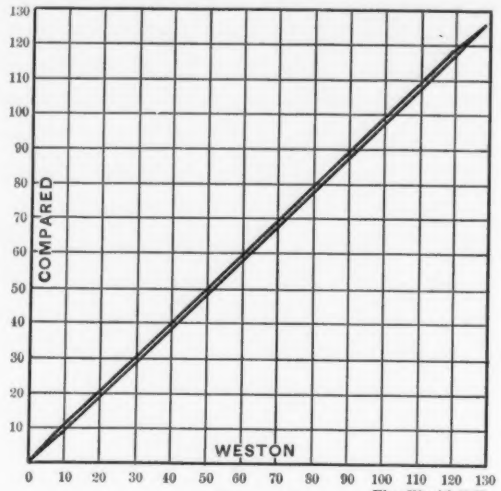


Fig. 4

Further, if A is the mean cross section of the armature, and μ its permeability, the flux through it will be

$$\varphi' = \frac{a\, p\, \mathfrak{F}}{\frac{l}{A\,\mu}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

or

$$\varphi' = \frac{4\pi n I A u a p}{10\, l} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

a being a reduction constant whose value varies with the particular instrument.

These results show the influence of the permeability of the iron armature. It is seen that the flux φ' is directly proportional to the permeability μ, and since the polar strength of the armature is also proportional to the flux it will vary directly with the permeability of the iron.

The law of the action of such instruments is,

$$F = \frac{m\, m'}{L^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

in which expression m designates the pole strength of the deflecting solenoid or coil, and m' the pole strength of the soft iron armature. This pole strength has already been shown to depend on the permeability of the iron; consequently, whatever affects the permeability of the soft iron armature will correspondingly alter the force of attraction F, between the armature and the coil. The reading on the scale of the voltmeter or such other instrument, as the pointer moves over it, gives primarily the strength of the attraction F, which for convenience is now universally expressed in terms of volts, amperes or watts.

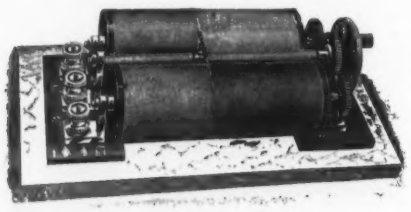


Fig. 1.—Variable Potential Rheostat.

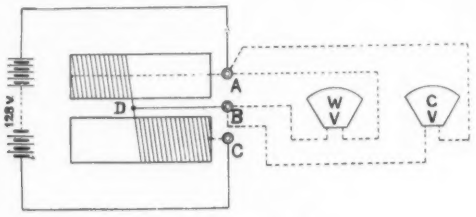


Fig. 2.—Connections for Testing with Variable Potential Rheostat.

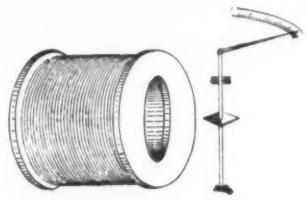


Fig. 3.

This brief discussion clearly shows:

(a) That for invariably accurate readings of such instruments the armature must magnetize with unvarying values of μ for a given current in the coil.

(b) That if the value of μ for a given current in the coil is not invariable, the scale readings will show a proportional variation, and the calibration will be in error proportionately to the variation in the permeability.

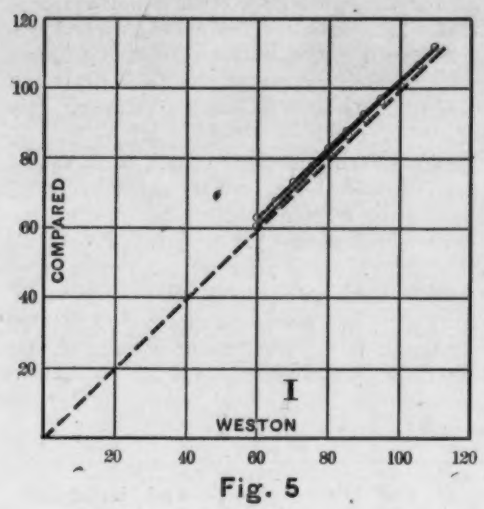


Fig. 5

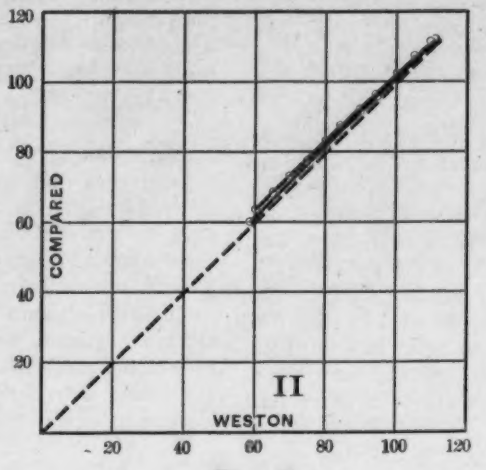


Fig. 6

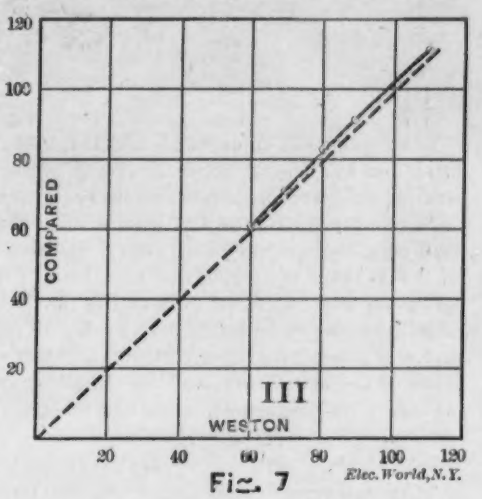


Fig. 7

Elec. World, N. Y.

CALIBRATION OF VOLTMETER.

THE TESTS.

The data given under this heading were all obtained in the same manner. The apparatus and method having been fully discussed above it remains to describe the operation for calibration to develop the hysteresis. An accurately calibrated voltmeter was used as a standard; this was the Weston instrument, selected for the fact that having a permanent field and no moving soft iron it is free from hysteresis, and will show the same calibration on both ascending and descending readings, and when the circuit has been frequently interrupted as well.

It was necessary to employ a source of e. m. f. which should be constant throughout the test, and this condition was met in the use of a storage battery of sixty cells. The voltmeter to be calibrated together with the standard Weston was attached to the terminals *A* and *B* (Fig. 2) of the variable potential rheostat. Before closing the circuit through the tested voltmeter the wire was reeled off cylinder *A* until a sufficiently low starting voltage was obtained. Both voltmeters were then placed in circuit and the wire slowly reeled back onto cylinder *A*, a pause being made at those scale divisions where it was desired to make a reading. The greatest care was taken not to reverse the movement of the rheostat wire to avoid the formation of a loop in the hysteresis curve. The current through the voltmeters being thus gradually and continuously increased to the maximum value possible, the rotation of the rheostat was reversed and the current continuously decreased to the initial value. At no time during the test was the current interrupted. Care was also taken not to jar the instruments during the tests, as mechanical jar would tend to overcome the hysteresis effect.

The various voltmeters under test will be designated as M, N, and O; for obvious reasons the trade names will be withheld, except in one instance, this instrument being no longer in general use. The list includes, however, many of the best known makes. All the instruments noted belong to one common type; they contain a movable armature of soft iron, singly, or in combination with a fixed piece of soft iron, for opening out certain parts of the scale.

VOLTMETER M.

This is perhaps the most widely used instrument at the present time. It contains no auxiliary deflecting parts. It is manufactured as a voltmeter, ammeter and wattmeter. The calibration is shown in Fig. 4, the data for which are the following:

TABLE I.

Voltmeter M.	Weston Ascending.	Weston Descending.	Voltmeter M—Error.
20	20.5	19.3	1.2
30	31	29.5	1.5
40	41.3	40	1.3
50	52	51	1.0
60	62	61.6	0.4
70	71.9	71.3	0.6
80	82.4	80.9	1.5
90	91.9	91.3	0.6
100	102.8	101.6	1.2
110	113	111	2.0
120	123	121.5	1.5
126	129		

The hysteresis loop is clearly marked and the hysteretic error fairly constant.

VOLTMETER N.

In this instrument, too, the deflected system contains soft iron, but no auxiliary iron is employed. This instrument differs from the preceding in the shape of the coil and in the position of the armature. It is manufactured in the three forms of meters for switchboard and laboratory purposes. The calibration shown in Fig. 5 corresponds to an e. m. f. continuously increased to the maximum and then immediately decreased, allowing no time for the armature to acquire a "magnetic set." A repetition of the calibration is shown in Fig. 6, with the modification that when the maximum

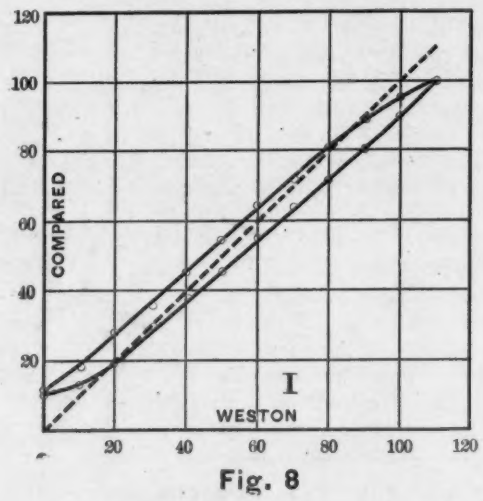


Fig. 8

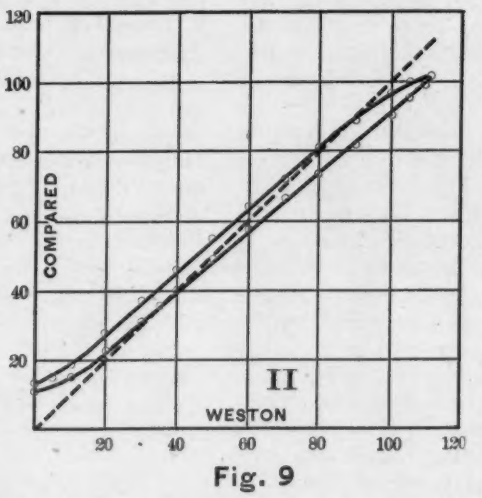


Fig. 9

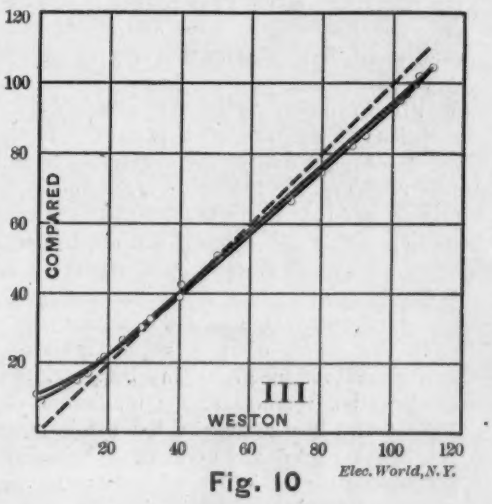


Fig. 10

Elec. World, N. Y.

CALIBRATION OF VOLTMETER WITH SOFT IRON ARMATURE.

e. m. f. was reached it was allowed to act on the instrument for ten minutes. The voltage was then decreased as usual.

TABLE II.

I. Weston.	II. Voltmeter N Ascending.	III. Voltmeter N Descending.	IV. Voltmeter N Descending.
60	61	62.5	62.5
65	66.25	67.5	67.5
70	71.5	73	73
75	77	78	78
80	81.75	83	82.75
85	87	88	87.5
90	91.75	92.5	92.25
95	96.75	97.5	97
100	101.5	102	102
105	107	107	107
110	112	112	112

The readings in columns II. and III. belong to Fig. 5, while those in II. and IV. belong to Fig. 6. It will be seen that this particular instrument showed practically no magnetic set.

Another property of soft-iron instruments is well brought out in the calibration shown in Fig. 7. During the calibration the key of the Weston voltmeter was kept closed; that of the voltmeter N, however, was depressed only at the time of reading. As usual the voltage was continuously increased and then decreased; the voltmeter N practically repeated its readings in each case. This test then leads to the conclusion that the remanent magnetism of the system, whatever its magnitude, does not sensibly alter over a short-time interval.

VOLTMETER O.

This instrument is no longer manufactured, but was at one time extensively used. It was manufactured both as a voltmeter and ammeter. In addition to the soft-iron armature there was an auxiliary strip of soft iron, so disposed as to open out certain parts of the scale. The continuous calibration, without an interval of rest at the maximum e. m. f., is shown in Fig. 8. The instrument not only departs from its scale at the upper and lower points of the calibration, but exhibits the very great hysteresis error of nearly 9 volts at the centre of the scale. The calibration shown in Fig. 9 differs from the preceding, in that the voltmeter was kept at the maximum reading for ten minutes before taking the descending half of the curve. It is noticeable that this procedure decreases the hysteresis area. Finally, in Fig. 10, is shown a calibration made by closing the key of the voltmeter O at the moment of reading. This still exhibits a slight hysteresis effect. This type of instrument was formerly much used both in England and France.

Another interesting set of curves was obtained from a voltmeter made by Deprez and Carpentier, No. 5849. The continuous calibration of this voltmeter is shown in Fig. 11, while in the calibration given in Fig. 12, the curious effect of a dwell of ten minutes at the maximum voltage is clearly shown. The system has lagged behind the impressed e. m. f., but in the rest interval gradually crept up to a higher magnetic value. Upon descending the lag increased, until at 50 volts it crossed the ascending magnetization. Again, in Fig. 13, which was taken by momentarily closing the key when observing, there is a slight persistence of hysteresis.

The four voltmeters discussed are selected from a large number of instruments which have been subjected to these tests. Practically none has been found to be free from hysteresis errors.

So far as the writer is aware, no similar tests have been published, and while the general opinion has been held that soft-iron instruments have a latitude of uncertainty in their readings, this has never been quantitatively expressed. The tables and curves given above are so conclusive that there is scarcely need of much further discussion of the data.

This type of instrument is eminently unsuited for the laboratory. No matter how carefully the instrument is calibrated the subsequent readings cannot be relied upon, for the error is not constant, but varies with conditions which cannot be accurately ascertained. It is in central stations that such instruments are especially found. Here the type is evidently unsuited for use as a voltmeter. It is a misnomer to call such instruments *meters*; they are evidently only indicators.

The mounting of these instruments is often as well done and as expensive as that of the D'Arsonval, or permanent-magnet class. It would seem that it is not the best engineering practice to prepare elaborate cases, coils and bearings for a system possessing such inherent defects, for the system is after all the vital portion of such instruments. The preceding discussion refers only to behavior with constant direct e. m. fs. With alternating e. m. fs. they are more reliable, yet hysteresis is not wholly eliminated, and they cannot be considered accurate. In common with all instruments containing considerable self-induction the calibration holds only for one particular frequency.

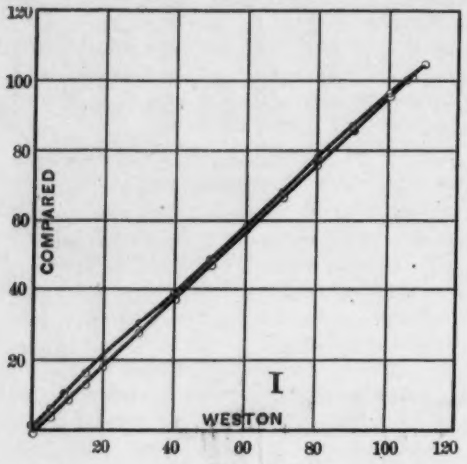


Fig. 11

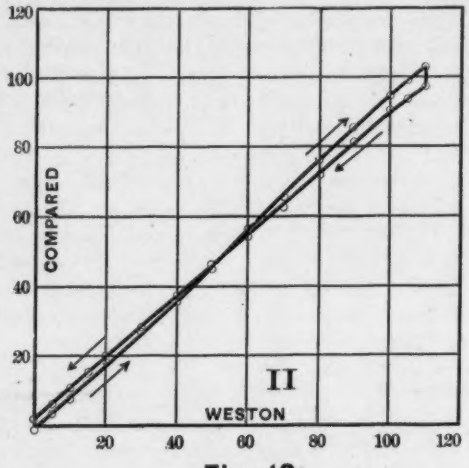
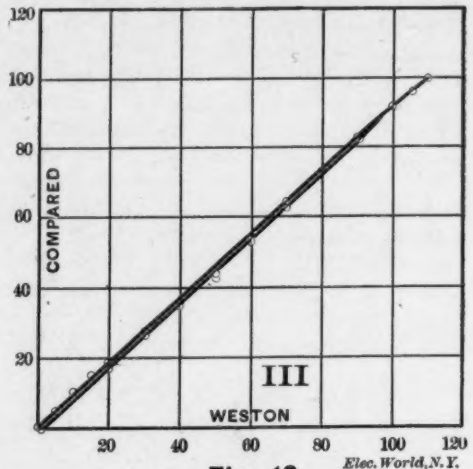


Fig. 12



Elec. World, N.Y.

Fig. 13

CALIBRATION OF VOLTMETER.

The Consolidation of the Westinghouse and Heilmann Interests in France.

A new company known as La Société Industrielle d'Electricité procédés Westinghouse has been formed, with a capital the equivalent of $2,000,000, to handle the work previously accomplished in France for the Westinghouse companies by La Compagnie Générale de Traction. The new company has also purchased from the receiver of La Société des Moteurs Electriques et à Vapeur J. J. Heilmann its property and business, including the shops at Havre, and excluding only the two electrical locomotives and patents upon the same. The English and American Westinghouse companies have turned over to the new French company all patents owned by them in France and colonies, and all rights hitherto invested in the traction company for the exploitation of Westinghouse apparatus in France, with exclusive privileges of manufacture and sale of the same, and the communication up to 1909 of all experience and discoveries made by the English and American companies. M. Heilmann will not be connected with the new company, but will devote himself to another concern which he has established for the promotion of his famous electrical locomotives, the rights to which have been purchased from the old Heilmann Company, now dissolved.

Electric Motors Gradually Replacing Steam Engines.

That electric power generated in central stations is gradually replacing steam power is shown very well in the annual report of the chief of the Bureau of Engines and Boilers in the city of Philadelphia. Out of a total of 3579 boilers under the supervision of that bureau there are 625 which are temporarily out of use, the chief reason being that electric power is gradually being substituted for steam power.

Design and Construction of the Twentieth Street Power Station of the Consolidated Traction Company, Pittsburg, Pa.*

BY G. F. GREENWOOD.

When the various cable and electric lines in the city of Pittsburg were consolidated the new company found itself in possession of seven power houses, four of these, cable power houses of the usual type; the other three, electric power houses. Before and during the reconstruction of the system these electric power houses were of course kept in operation, but there arose the problem as to what arrangements must be made for supplying power to the much larger system when completed.

None of these plants were well situated with regard to coal and water supply, the most important factors in the location of a large power house. The cable power houses were necessarily located on the streets along which the cables were operated, and therefore little regard was paid to coal and water supply. These plants stood on valuable ground, the cost of hauling coal by wagon was large, and lack of water rendered the use of condensing engines impractical.

The electric power houses were somewhat better off in regard to coal supply, but two of them were too far from centre of system, while the other had no suitable water supply and only one source of coal supply. It became evident, therefore, that one or more new power stations were demanded in localities not too far removed from centre of system, and where coal and water were easily and surely obtainable.

In deciding between one large plant and two or more smaller ones Pittsburg's marked geographical peculiarities largely influenced the result. The street railways converged in the crowded business portion down town, and again at East Liberty, after traversing a district of heavy grades. This brings the centre of the system in the midst of the hills, at a considerable distance from available coal and water supply, hence it was impractical to put power house in this part of the system. Railroads are compelled to follow the Monongahela and Allegheny valleys, so that both coal and water are readily obtainable along the banks of these rivers. A location on the Allegheny river offers advantages of far better water, with equally good coal facilities, nearer to the centre of the system, and of less difficulty in obtaining land.

With so little choice in location, the advantages of a single power house, rather than two or three in different parts of the city, are clear. Danger of fire and of accident to a single plant may be eliminated by proper construction, while much of the initial cost and operating expense of the plant is independent of the size, and, therefore, as great for each of the smaller plants as for the large one. To illustrate the economy of a single power station over the several original ones, your attention is called to the fact that the operating expenses of five of the old plants are about two and one-quarter times as great as those of the new one. The new station is larger than the combined capacity of the old stations considered, yet runs for less than one-half the daily operating expense. The value of the real estate of the separate plants is sufficient to cover the cost of construction of the new station.

The location finally obtained is at Twentieth street, between Railroad street and the Allegheny river; the property being 177 feet deep, and 360 feet to harbor line; the length of the building is limited to 265 feet by the 30-foot right of way of the P. J. R. R. crossing the property at the river end; thus coal may be secured from either the B. & O. system, the Penna. Lines, or ultimately from the river, while an unlimited supply of fairly good water is close at hand. The depth of the property is not as great as was desired, and in order to allow room for future extension, close attention was paid to concentrating the plant within as small floor space as possible.

The total power required was deduced from power data from the P. A. & M. Lines in Allegheny, and from the results of the testing car, and checked later by observations on the Fifth Avenue Line. This, with the proposed schedule, gave the capacity of the station to be about 6,000 k. w. This was divided among six machines, with foundations, etc., for two more, without making additions to the building. By economizing space it was arranged so that the plant may then by doubled in size with very little trouble. Until this becomes necessary a part of this space is used for the storage of coal. The plant will use about 100 tons of coal per day, thus requiring a large storage capacity in case of strikes.

Coal is to be received by rail and dumped into hopper under ash bin at river end of boiler room. It passes through an automatic weigher into the buckets of the Mead conveyor underneath, is elevated about 50 feet and passes along over the coal bin, being dumped anywhere it is desired. Conveyor then passes on and down into the tunnel beneath the boiler room, and when not carrying coal may be used to carry ashes from ash hoppers, along tunnel to the ash bin at river end of building.

When it is wished to store coal the chutes leading into coal storage room are opened, the coal being obtained again when wanted by passing down into conveyor in tunnel, and being again hoisted to upper coal bin. The conveyor can handle 40 tons per hour, and takes about 15 horse power to operate. When the plant is doubled another line of boilers takes the place of the present coal storage room with second engine room beyond, and a new place for coal storage will then have to be provided on the unoccupied river front.

In the selection of boilers return tubular boilers were out of the question, owing to the large amount of space they occupied. Sectional water-tube boilers were chosen, rather than internally fired boilers of the marine type, because of their being cheaper, equally efficient, safer, and better adapted to the exacting requirements of street railway work. Each battery of two boilers is provided with a separate iron stack, 66 inches in diameter and 147 feet high, this being cheaper and more economical of space than a system of flues connecting with a single large stack. A single stack would have to be 15 feet internal diameter and would occupy as much room as a battery of boilers, aside from the space taken up by the flues, and would cost very much more. Under partial load there would be loss of efficiency due to the large amount of air necessary to be heated in order to obtain the requisite draught.

The boilers are Babcock & Wilcox water-tube boilers of special design, there being six batteries of two boilers, of nominal rating 375 horse power each. The boilers are shorter and higher than the usual type (in order to economize floor space) having three 36-inch drums 20 feet long and 18 sections of 13 4-inch tubes, each giving about 4,000 feet of heating surface. Hawley down-draught furnaces are used, having a grate surface of 60 square feet. The pressure carried is 125 pounds, the boilers having been tested under hydraulic pressure to 300 pounds. The Hawley furnace is guaranteed to show 10 per cent. greater efficiency than the ordinary flat grate, and to be able to burn 40 pounds of coal per square foot of grate per hour, with prevention of 92 per cent. of the smoke. At 25 per cent. above rating one man can handle battery of two boilers; the boilers are guaranteed to develop 75 per cent. efficiency with the Hawley down-draught furnaces, with less than 1 per cent. of moisture at full load or 1½ per cent. at 50 per cent. above rating. In the acceptance test the above guarantees were obtained.

Brass feed piping was selected, inasmuch as the freedom from corrosion and repairs overbalanced the greater first cost. Cast steel steam piping was selected, because of its greater safety and durability. Duplicate piping was not provided, as it was considered that the money could be better spent on the main line than on a duplicate line not used often enough to be sure that it was in good order.

In the design of the engines, horizontal engines were chosen, because (contrary to the usual statements) they can be put in even less floor space than vertical engines, are more readily accessible for attendance and repairs, and are less expensive. Low speed compound condensing engines were chosen because they were found, on calculation, to be the most economical under the conditions present.

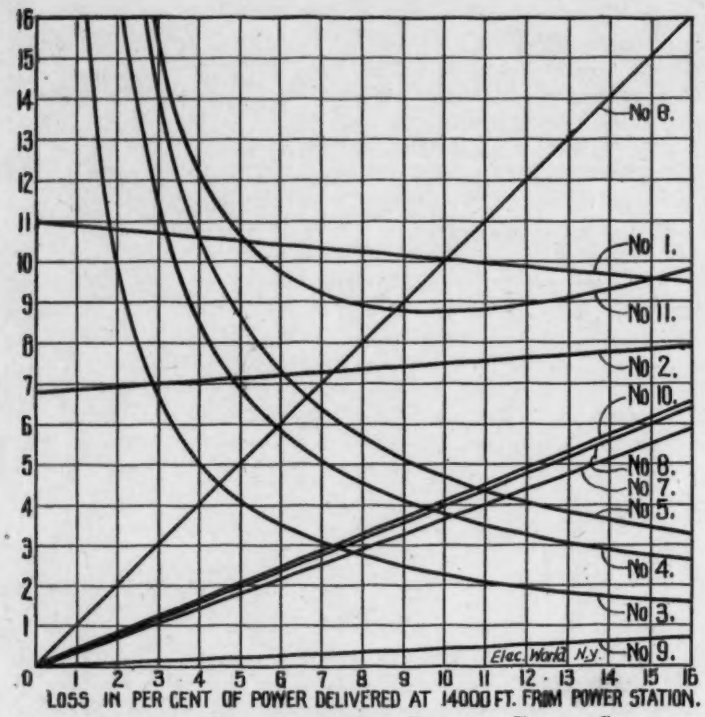
The engines were made by the Pennsylvania Iron Works, of Philadelphia, and are of very massive and plain design, the high pressure cylinder being 36 inches in diameter; the low pressure 54 inches, and the stroke 48 inches. The two bed plates for the high and low pressure sides are each made in one casting, the two main bearings being 20 inches in diameter and 40 inches long. All piping is beneath level of engine room floor.

The normal speed at full load is 80 r. p. m., 82 at no load, and 77 at 50 per cent. overload—the speed not to rise above 86 if the latter load be suddenly thrown off. Corliss valve gear is used, both high and low pressure admission being governed. A large reheater is placed between the two cylinders. The fly wheel is 20 feet in diameter and weighs 100,000 pounds.

*Abstract of paper presented before the Engineers' Society of Western Pennsylvania.

Lubrication is accomplished by an oil pump. A jet condenser is used with direct-connected differential air pump, of interesting design, calculated to maintain 25 inches vacuum at 50 per cent. overload, when the overflow water is being forced out under 10 foot head. The pump is a differential double-acting pump of 10 inches stroke, having a 20¼-inch plunger in tandem with 30-inch piston on either side. This gives a discharge of about 2 cubic feet on both up and down stroke from each side. A counter balance is attached to the outer end of pump.

A direct connected air pump was chosen for the following reasons: The river level varies so much that any style of pump would have to be designed to do more than is ordinarily required of it, hence the pump will rarely be running at full load, and will therefore be less economical than in the case of more uniform water supply; the effect on the economy, however, is less in case of direct connected air pump where it practically forms part of the friction load of a large compound condensing engine, than in the case of either a single separate pump or a number of smaller pumps designed for economy. Separately driven pumps are more expensive (if equal workmanship is obtained), because the cost of steam cylinders and valve gearing is added to that of the pump itself. Starting with a direct connected air pump is very much easier, and practically no attendance during operation is required. The main disadvantage is that the engine must be run non-condensing in case of break-down of its own pump.



Curves Showing Most Economical Drop in Feeder System of Consolidation Traction Company.

All figures are on the basis of 1000 horse-power delivered.
No. 1. Volts at Motor with 1100 at Switchboard. Scale, 100 volts.
No. 2. Amperes at Motor. Scale, 100 amperes.
No. 3. Circular Mils Required. Scale, 1,000,000 circular mils.
No. 4. Capital invested in line at $1645 per mile of 500,000-c.m. Cable. Scale, $10,000.
No. 5. Interest and Depreciation, 12½ per cent., on No. 4. Scale, $1000.
No. 6. Power Lost in line. May also represent necessary increase in power station capacity. Scale, 10 horse-power.
No. 7. Value of Wasted Power at $36.50 per hp-year. Scale, $1000.
No. 8. Increase in power house investment at $40 per horse-power. Scale, $1000.
No. 9. Interest, Depreciation, etc., 10 per cent. on increase of power house capacity at $40 per horse-power. Scale, $1000.
No. 10. Sum of No. 7 and No. 9. Scale, $1000.
No. 11. Total Portion of Annual Expenditure Dependent on Size of Feeders, Sum of 5 and 10. Scale, $1000.

Coming now to the electrical side of the plant, in the choice of a system, one could choose between the 500-volt direct current system, in almost universal use throughout the country, and the polyphase alternating current transmission at high voltages to substations where transformers and rotary converters would deliver the 500-volt direct current to the lines.

The latter system would involve high voltages on iron poles in crowded city streets, and the sub-stations would contain rather costly machinery and require constant attendance. In addition, each sub-station would have to be designed to take care of the average maximum load, which might come on its feeders during the very widely fluctuating demands of a street railway system, while nearly all of the time this machinery would be running underloaded. Hence, from an engineering standpoint this system is hardly advisable, while from a purely commercial point of view one is hardly willing to be responsible for the expenditure of a large sum of money on what may properly at the time have been considered an experiment. A higher voltage direct current system was not advisable, first, because special generators, motors, etc., would have to be installed; this change from standard practice meaning an increased expense, which would be counterbalanced in saving in copper, and second, because of increased danger to life and property from wires in crowded city streets. The standard 500-volt system was therefore continued in use; certain advantages can be obtained, however, by what may be called the "three-wire system."

The switchboard is so arranged that any dynamo may be run alone or in parallel with others, with either its positive terminal to one bus bar, and its negative to ground or with postive to ground and negative to another bus bar, while any feeder of the system may be connected to either bus bar.

Suppose, then, that the down-town districts are connected to the positive bus bar, and suburbs to the negative; the feeding load on the two sides is equal—the current going down town by means of the positive feeders will, after passing the motors, flow to the suburbs through the ground, distributing itself over the several lines of rail, and will pass through the motor in the suburbs, and thence to station by means of the negative feeders, no current whatever returning through the ground to the station.

If, as is always the case, the loads are unequal on the two sides, the difference in current only will return to the station by means of the ground or neutral. This corresponds therefore to a 1,100-volt-system—with both positive and negative overhead feeders rather than 550-volt system with positive feeders and negative ground return. The advantages are the somewhat smaller drop and great freedom from electrolysis due to the fact that large current does not return to the station through the ground, but distributes itself over a large area of the city, with the resultant decrease in the necessary investment in ground wire.

The disadvantages are complication of the switchboard, and the necessity of having special 1,100-volt circuit breakers on the lines, since failure of one of these breakers would produce short circuit. By merely connecting all the feeders to one bus bar the system becomes the usual one, but if intended to work along under such a condition, large ground returns must be provided, and thereby the saving in investment annulled.

In the design of the feeder system two extremes are to be avoided—either having too small overhead wires, in which case the cost of power alone due to resistance of feeder becomes excessive, or having too large overhead wires, in which case the interest and depreciation on the investment involved becomes excessive.

It is evident that there is a happy medium which represents the most economical condition of affairs. The calculations gone through are shown graphically in the accompanying figure, and lead to a result which, curiously enough, for the cost of power and the average distance in the present case, coincides with the value usually assumed off-hand in such work.

Another feature which may be mentioned here is the use of the storage batteries as regulators at different points in the system. Three of these batteries are already in use; they are connected directly on to the line, and during the greater part of the day act as automatic regulators, at times discharging and helping the power house when the load rises momentarily, and charging again when the load falls below the average, thus keeping the potential and the load on the power station more constant, and avoiding the necessity of having more engines running at less than full load, in order to take care of the greater momentary heavy load. During the busiest hours the battery discharges continuously; charging continuously between midnight and 5 A. M. to compensate for this drain.

The dynamos are standard Westinghouse 550-volt railway generators, of nominal 800 kw capacity; during a continuous run at full load or one hour's run at 50 per cent. overload no part of the machine shall rise more than 40 degrees centigrade above temperature of surrounding air.

One of the novel features of the plant is the interlocking pneumatic switchboard furnished by the Westinghouse Company. It is the first application of this kind of apparatus to railway work, although somewhat similar to the alternating current switchboard of the Cataract Construction Company at Niagara Falls. All the machine and feeder switches and circuit breakers are controlled by air valves on ornamental iron stands on a platform raised above the engine room floor. The bus bars, switches and other apparatus are in the vault below, and the air valves interlock in such a way that mistakes in manipulation are hardly possible. Each generator has a generator stand on the upper platform provided with an ammeter, hand wheel for regulating the potential, a voltmeter connection, a tell-tale lamp showing when circuit breaker is out and the two air valves, one controlling the main switch and the other the circuit breaker.

Each feeder stand has a similar equipment, with the exception of the rheostat and voltmeter connection. In addition, there is a voltmeter stand and an ammeter stand, each carrying three Weston instruments, and lighting stand controlling the lights throughout building. The feeder connections are 1,000,000 circular mils lead-covered cables which run through conduits in the basement from the switchboard vault to a cable vault in a corner of the building, thence through a tunnel 435 feet long under the A. V. R. R. freight yard into conduits, again to manholes at Twentieth street and Penn and Liberty avenues, where the connection to the overhead feeders is made. When the two remaining units are installed the cost per horse power installed will be about $70.00, without taking into allowance the fact that foundations for an equal number of boilers have been provided in addition.

The Next Convention of the American Street Railway Association.

The eighteenth annual meeting of the American Street Railway Association and third annual meeting of the Street Railway Accountants' Association of America will be held in Chicago October 17, 18, 19 and 20, 1899, at "Tattersall's," State and 16th streets. President Charles A. Sergeant, Secretary and Treasurer T. C. Penington; Walter H. Holmes, of Kansas City; Albion E. Lang, of Toledo; George A. Yuille, of Chicago; Frank G. Jones, of Memphis; John I. Beggs, of Milwaukee, and Ira A. McCormack, of New York, members of the Executive Committee of the American Street Railway Association, met in Chicago on February 6 and 7 and completed all the preliminary arrangements for the convention.

The hall selected is well suited to the purpose of the exhibits, having a clear floor space without columns of 50,000 square feet. The meeting rooms of both associations will be under the same roof, with ample retiring and committee rooms. The hall will be well heated and lighted, the light during the hours of the day leaving nothing to be desired. All the exhibits will be on the same floor, and there will be little choice as to location. All electric power necessary will be furnished.

The last day of the convention will be set apart for the systematic and careful inspection of the exhibits by the delegates, a fact which will be appreciated by all exhibitors. The banquet will be given on the night of the last day, at which the installation of the newly-elected officers will take place. The committee resolved to make unusual efforts to secure the attendance of representatives of the mechanical, operating and auditing departments, which will make the convention of great practical value to those departments, the attendance of delegates having previously been largely confined to the administrative departments.

The following subjects were selected upon which papers should be read: "Maintenance of Car Equipment"; "The Modern Street Railway Shop: Its Design, Machinery and Shop Practice"; "Train Service, and Its Practical Application"; "Investments in Street Railways: How Can They Be Made Secure and Remunerative?"; "Construction and Maintenance of Railway Track."

The headquarters of the Association will be at the Auditorium Hotel and Auditorium Annex. During the visit of the committee the local companies showed them every courtesy, and between business and pleasure they were few moments unoccupied.

Professor Morse Honored in the New Currency.

Of the new United States silver certificates, the greenback side of the two-dollar denomination bears an engraving of Prof. S. F. B. Morse, as well as one of Robert Fulton.

The Past Year's Advance in the Art of Telephony.

BY KEMPSTER B. MILLER.

The year 1898 was one of steady improvement in telephone apparatus and methods. Few really important inventions were placed before the public and few radically novel ideas were evolved, or, if so, were not brought to light. Few new principles have been applied to the solution of old problems, or so utilized as to make possible new ones. No second Milo G. Kellogg has appeared on the scene with an issue of 125 patents in a single day, which number is, I believe, greater than the entire number of telephone patents granted during the year.

The development has been more in the line of the perfection of details, the application of methods already devised, or of principles already well known, to the general betterment of telephone service. The improvement has not been confined to the Bell companies, and has perhaps been more marked in the independent companies, although this is undoubtedly due to the fact that there was greater room for improvement.

One of the most healthful signs among the independent companies is the more dignified and businesslike manner noticeable in their business methods. The policies so obnoxious a few years ago are happily disappearing among the better class of manufacturers, and a spirit of "live and let live" is on the increase. Another not less hopeful sign is the increase of the knowledge of the principles of telephony among the independent manufacturers and users. The idea that a 1000-ohm induction coil is in all cases better than one of low resistance, and that a 1,000,000-ohm coil would be a further improvement, is happily finding fewer and fewer adherents. The meaning of the term, "10,000-ohm magneto," is beginning to be understood, and the cases where bridging instruments are connected in series in the line are happily becoming fewer, although it must be acknowledged that they are still quite numerous.

The reason for the better understanding of telephones and telephony is undoubtedly due largely to the fact of the appearance among the independent ranks of a number of good telephone engineers. Still another important advance made by the independent companies is the adoption in some cases of a standard form of instrument for toll lines among the companies operating in the same section of the country, and the establishment of rules for the construction of the lines themselves, by which a fair degree of uniformity is obtained in long-distance service. It is only when the independent companies have awakened to the necessity of such a procedure that long-distance service can be obtained satisfactorily over any considerable area of country.

In the Bell companies there has been a tendency toward better service, due to a utilization of the important inventions in the past of such men as Scribner, Stone, Hayes, Dean, McBerty and a host of others in the Bell or Western Electric ranks, who have done so much toward bringing the great systems of the great corporation to their present high degree of perfection. I refer more particularly to the almost universal adoption of the lamp signal or relay boards and the centralized battery systems in the new installations of the Bell Company. The long-distance service has ceased to be a source of astonishment, and no sooner does some one make the prediction that the practical limit of long-distance telephony is reached than the telephone engineers immediately proceed to overreach it. The establishment of a telephone connection between Omaha and Boston is one of the latest achievements in this line, and has occurred during the past year.

Referring more particularly to the different improvements produced during 1898, the telephonic relay, devised by Mr. J. S. Stone, of the Bell Company, is very interesting, and may be productive of good results. This was described by me in an article in these columns.* It consists merely in placing the variable resistance button of a solid-back transmitter in operative relation with the diaphragm of a receiver of special form, the entire mechanism being enclosed in a vacuum. There is absolutely nothing new about this, except the vacuum, but if it gives, as Mr. Stone claims, an increase in volume of telephone transmission, it is a very simple and easily applied remedy to the heretofore unsurmountable objection to the telephone relay.

Mr. W. W. Dean has again been responsible for some very ingenious developments, one of which accomplishes the automatic ringing of the called-for subscriber when the operator inserts the calling plug into the jack of his line. This is accomplished by a

*See THE ELECTRICAL WORLD October 1, 1898.

rather complicated system of relays in the cord circuit, the relay in each case holding the circuit of the generator closed to the subscriber's line, and thereby ringing his bell until he removes his receiver from its hook. When he does this, the resistance of the line circuit is lowered, thereby allowing enough current to flow through the line to operate the generator-controlling relay, and thus automatically cutting off the generator. Another, and later, system devised by Mr. Dean does away with the relays placed in series in the cord circuit, used to control the circuits of the supervisory lamp signals, which automatically inform the operator when one or both subscribers are through talking. He uses the windings of the split repeating coil, which is placed in the cord circuit, for the accomplishment of the same purpose as the relays, making these coils energize a core at the proper time, which core attracts a relay armature and thus controls the lamp signal, as in the case where separate coils were used.

The cord circuit, upon which Mr. Dean's is an improvement, is shown in Fig. 1, and is in reality a very late development in telephony, being patented by Mr. Charles E. Scribner early in 1898. In this the magnets of relays S and S^2 are included in the sleeve strands of the cord circuit. The split-repeating coil I is connected across the tip and sleeve strands, and includes between its halves the battery B, this method of connecting the battery being the invention of Mr. Hammond V. Hayes. The current from the battery flows through the two halves of the repeating coil and through the magnets of relays S and S^2, to the two subscribers' stations, with the lines of which the plugs P and P^2 are connected. If the subscribers' receivers are on their hooks no current will flow through the circuits of the lines, because the circuit is opened by a condenser at each station. The relays S and S^2 will, therefore, not be operated, and the current from the battery B^1 will flow through the lamps r and t, and through the third wire c of each cord circuit to the grounded thimbles of the jacks. The lamp r or t will, therefore, be lighted according to whether one or the other of the subscribers' receivers is on its hook. When either subscriber takes down his receiver, a low resistance path will be established between the two sides of the line, and the current from the battery B will energize the corresponding relay S or S^2, thus closing a shunt about the lamp r or t and extinguishing it. The going out of both lamps will notify the operator that the subscribers are in communication. When either subscriber hangs up his receiver the relay S or S^2 releases its armature, the shunt about the lamp is broken, and its illumination shows the operator that that subscriber is through with the circuit.

This system is ingenious, and is the result of a series of inventions begun in 1892, when Mr. Hayes devised the split coil arrangement of supplying transmitter current to the subscribers' stations. There is, however, a slight objection in that the relay coils S and S^2 are included serially in the circuit through which the telephone currents pass. This is a more serious objection that would be the case were the ordinary local circuits used at the subscribers' stations, for it amounts to putting an impedance coil in both the primary and the secondary circuit. Mr. Dean's remedy for this difficulty is shown in Fig. 2, in which the repeating coil I is provided with a core adapted to act on the armature q, and thus control the circuit of the lamp r. On the opposite side of the battery is located the retardation coil M, the core of which is adapted to act on the armature u, and thus control the lamp t. The strands of the plug P extend through two windings m and m^2 of the repeating coil, and thence to the poles of the battery B, while the strands of the plug P^2 are continuous through the windings of the coil M, and extend therefrom to the poles of the same battery. Connected across the strands of the plug P^2, in parallel with the windings of M, are the two helices n and n^2 of the repeating coil. A condenser N is placed in circuit between the coil M and the repeating coil, to prevent a partial short circuit of the battery B. When the subscriber with whose line plug P is connected has his receiver removed from its hook, current from the battery B flows through coil m^2, causes its core to attract the armature q, and thus extinguish the lamp r by short circuiting it. When the subscriber, with whose line plug P^2 is connected, removes

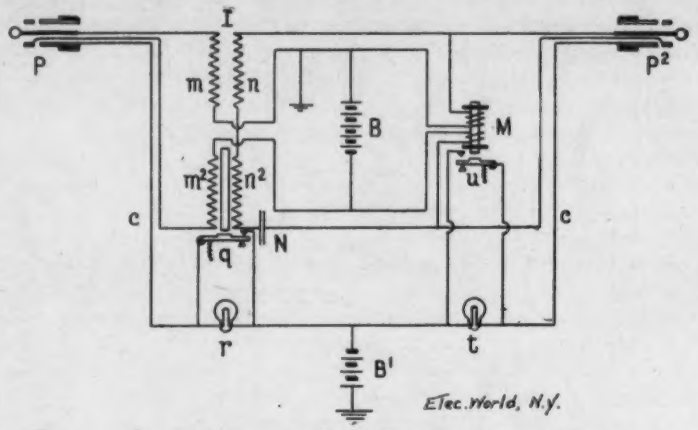


Fig. 2.—Arrangement of Cord Relays in Dean System.

his receiver, current flows through the retardation coil M, causing its core to attract the armature u, and thus extinguish the lamp t. When the subscribers hang up their receivers the relays q and u are released, and the lamps lighted by current from the battery B^1 flowing in the local circuit at the central office. Variations in current in the circuit of plug P act inductively through the repeating coil, on the circuit of plug P^2, and vice versa..

This improvement illustrates the tendency toward bridge connections, to the exclusion of the old series arrangement. The repeating coils and the retardation coil become high-impedance relays of abundant attractive power and wide range of action. They are in series with the battery, so as to attain a maximum attractive power on their armatures, and at the same time are always in bridge across the talking circuit, where they prevent the short circuiting of the voice currents through the battery.

An invention which is, to say the least, ingenious and interesting from a scientific standpoint is one by Mr. W. D. Gharky, one form of which is shown in Fig. 3. The idea in this is to utilize the well-known cooling effects at the alternate junctions of a thermopile, to cool the working parts of a microphone. In other words, it is proposed to utilize the Peltier effect to dissipate some of the heat due to the Joule effect. Mr. Gharky places the junctures of the thermopile, which will be cooled by the passage of the current, in proximity to the working parts of the microphone, as shown in Fig. 3. Current from the same battery which actuates the microphone also passes through this thermopile, thereby tending to keep the various parts cool and allowing a greater efficiency of transmission. This presents a new field for the possible improvement of the microphone.

An invention of merit has been made by Mr. H. P. Clausen, of Chicago, and the ingenuity by which he attempts to avoid the claims of the Carty bridging-bell patent recently sustained is well worthy of comment. The arrangement of instruments is shown in Fig. 4, which represents a party line having two instruments connected in multiple. The hook-switches are of the ordinary type, having two contacts made while the telephone is in use, and one while it is not

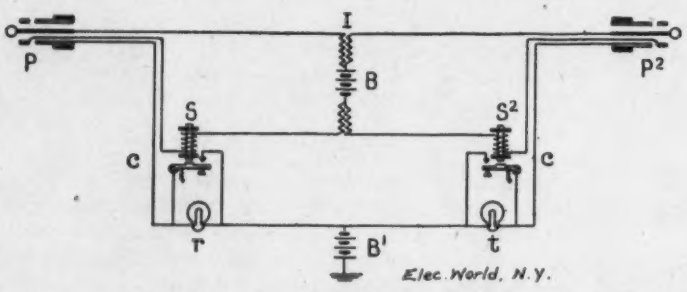


Fig. 1.—Arrangement of Cord Relays in Scribner System.

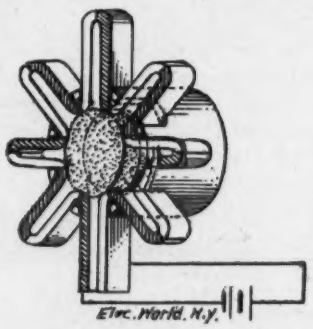


Fig. 3.

in use. The upper contacts on the hook perform exactly the same functions as in the ordinary telephone set, and need not be described. The lower one completes the circuit from the side *A* of the line through the high-wound call bell *C* and the hook lever, to the line *B*. The high-wound call bells bridged across the line present so great an impedance as to prevent the short circuiting of the

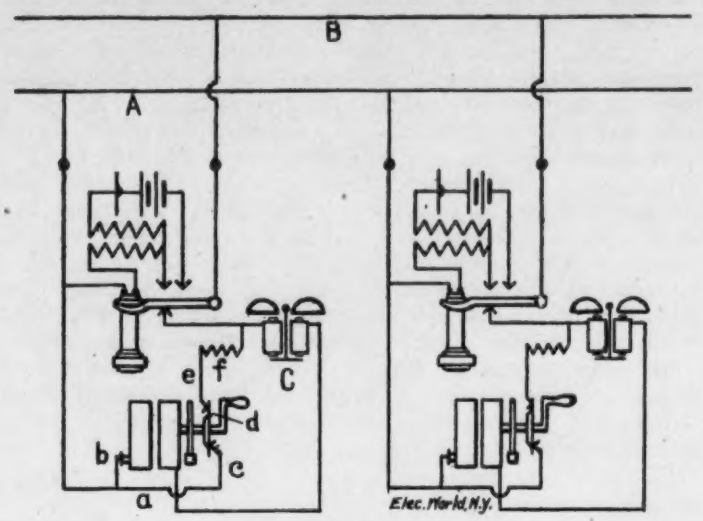


FIG. 4.

voice currents, which are thereby compelled to pass along the line wires, finding a path between them only at the two stations, where the receivers are removed from the hooks. The generator is normally shunted by the wire *a*, which has one terminal connected with the armature spindle contact *b*, and its other terminal connected to a spring *c* resting against the disc *d* carried on the crank shaft, and therefore in connection with the frame of the generator which forms the other terminal of the machine.

It is evident that in this position the generator can send no current to line on account of the shunt *a*. When operated, however, the disc *d* is automatically pushed out of contact with the spring *c* and into contact with the spring *e*. This breaks the shunt and connects the generator across the circuit of the two line wires *A* and *B* through the small resistance coil *f* and the spring *e*. If we assume that the spring *e* and the coil *f* are not present, then it is evident that the generator would upon the breaking of the shunt *a* send its current through the ringer coil *C*, as in the ordinary series telephone. With the coil *f* present, however, the generator, when operated, sends its current through this coil and the bell magnet in parallel. The only object of the coil *f*, which is given a resistance, possessing practically no self-induction, of about 100 ohms, is to divert a very small portion of the current from the generator through the bell *C*, thus causing it to ring. The great volume of the current, however, from the generator passes directly to the line

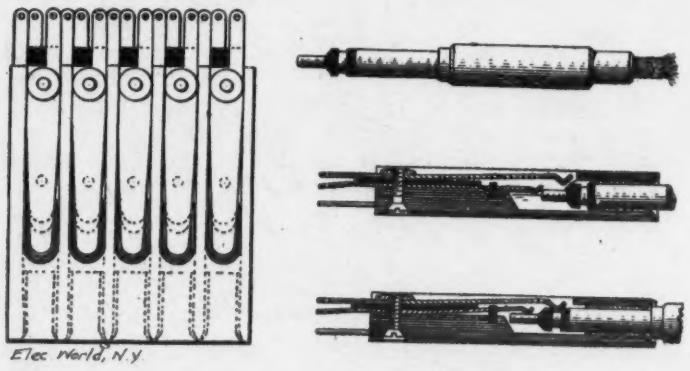


FIG. 5.—SWITCHBOARD JACKS AND PLUG.

through the resistance *f*, and passing along the lines wires *A* and *B* operates the various call bells *C* bridged across them at the other stations.

It may be argued that it is an objection to include the coil *f* in series in the circuit of the generator. It is a slight objection, as it amounts to the adding of a few miles of line wire to the circuit at the end nearest to the generator. In the ordinary bridging bell system the local bell is always in multiple with the generator which is being operated, and therefore takes more current from the generator than any of the other bells of the line. The one objection will probably fully offset the other. Another very neat feature of this invention is the fact that by removing the coil *f* and the spring *d* the circuits are made identical with those of the ordinary series instruments, and, therefore, to change this to a series instrument one has only to pull out the coil *f* and replace the ringer coils with those having a low resistance.

Coming now to smaller things, the spring jack and plug shown in Fig. 5, which is the invention of Mr. Scribner, shows the construction of some of the best classes of apparatus. This idea was evolved several years ago, and has been put into quite extensive use, but was only patented during the last year. The feature of the invention consists in so conforming the parts of the plug and spring jack that the dissimilar portions will not come in contact during the insertion or withdrawal of the plug. The means of accomplishing this is obvious from the drawings, each successive contact on the plug being made larger than the one preceding it, and the insulating bushings between the plug's contacts being made of larger diameter than the contacts themselves.

First Experiments with an Hydrofluoric Acid Primary Cell.

BY J. P. ALEXANDER.

In May, 1897, I made a series of simple experiments with hydrofluoric acid as a battery fluid. Ordinary commercial acid was utilized, and glass jars coated with paraffine served as the containing vessels.

The acid was diluted with water in varying proportions, the following data being given for a 75 per cent. solution of the acid. Better results might have been gained by further dilution. The amperage was taken on short circuit through a Weston instrument, a Weston battery voltmeter being also utilized. The plates had an area of about eight square inches below the surface of the liquid:

AMPERES ON SHORT CIRCUIT.

	Amperes.	Current.
Zn and C	0.5	Falling.
Pb and Zn	0.25	Falling.
Fe and C	0.2	Falling.
Z and Fe	1.0	Steady.
Fe and Sn	0.1	Falling.

COMPARISON OF E. M. F. SERIES.

KOH Solution.	HCl Solution.	KSO_2 Solution.	HF Solution.
Zn	Zn	Zn	C
Sn	Cd	Cu	Cu
Cd	Sn	Cd	Sb
Sb	Pb	Sn	Bi
Pb	Fe	Ag	Pl
Bi	Cu	Sb	Hg
Fe	Bi	Pb	Fe
Cu	Ni	Bi	Pb
Ni	Ag	Ni	Zn
Ag	Sb	Fe	

One Telephone and Three Telegraph Circuits on Two Wires.

Patent No. 619,157 issued February 7, 1899, to Stephen Dudley Field describes the principles and in detail the apparatus required for obtaining with two wires one metallic telephone circut and three ground-return telegraph circuits, all non-interfering. The system is an elaboration of the composite system now used on the long-distance lines in this country, whereby two line wires constitute a metallic telephone circuit, each being separately used for a ground-return telegraph crcuit. The third telegraph circuit of Mr. Field's invention consists of the two line wires in multiple with each other with a ground return. The signals used in this fourth circuit are smooth wave forms produced by an inductive transmitter, the waves being simultaneously generated in the same direction in both line wires so that they do not appreciably affect the telephones connected between the two. They are kept out of the relays of the other two telegraphic circuits by the impedance coils of the latter. The waves of current operating the fourth circuit are generated by the movement of an armature over the coil-wound poles of a permanent magnet. The pendular armature is moved quickly in one direction or the other by a piston operated by compressed air, the valve to be in turn controlled by the key, giving single waves alternately positive and negative, and a wave length sufficiently short to choke them back from the impedance coils of the other telegraphic circuits.

Electricity on Board Ship.*

BY S. DANA GREENE.

The modern first-class battleship requires about 2000 indicated horse-power to drive all the auxiliaries at full load, and the first-class cruiser about 1200 indicated horse-power. These auxiliaries, however, are never all in use at the same time, using maximum power, and it can be assumed that about one-half these amounts (i. e., 1000 indicated horse-power and 600 indicated horse-power) will be required at any one time. They are scattered all over the ship, from the anchor-hoist forward to the steering engine aft, and from the deck winches and boat cranes on the spar deck to the bilge and fire pumps in the engine and fire rooms, 30 or 40 feet below. Some of them, such as condenser, air, circulating, feed, bilge and fire pumps, and fire-room blowers, are necessarily located within the engine and boiler room compartments, where the temperatures are always high, and where steam, oil, water and coal dust are always present in greater or less quantities. Others, located on the spar deck, are exposed to salt water and air and to the varying conditions of sea and weather.

With these scattered locations it is obvious that power, generated at a central point, must be distributed throughout the ship. For this purpose there can be used either steam, hydraulics, compressed air or electricity. Hydraulics and compressed air not only have a low efficiency of conversion (from steam), but it is difficult to prevent leaks, freezing, bursting of pipes, etc. They have both been tried to a limited extent, and both found wanting in service. This leaves steam and electricity as the two remaining systems of distribution from which to choose. As between the two, steam has the following disadvantages:

1st. Danger to life. The bursting of a steam pipe, whether in or out of a fight, is a serious matter, and likely to disable any of the crew who are in the compartment where the accident occurs. It has been abundantly proven in our civil war that men will not stand up against steam or hot water, when they will face shot and shell without flinching. Many of our vessels operating in inland waters during that war had several lines of hose coupled to a hot-water tank and led out every night to guard against boat attacks. These hoses were successful on more than one occasion in repelling boarding parties. While the main steam-leads fore and aft can be run below the protective deck, or behind the armor belt, vertical branches must run to all auxiliaries on the upper decks, and many of these must be used in action. The effect of a steam pipe carrying 100 pounds' pressure bursting or being shot away in a compartment where there may be thirty or forty men at the guns or passing ammunition, would undoubtedly be to kill or disable every man in the neighborhood and demoralize thoroughly that part of the ship. On the other hand, if a wire is shot away, one or more auxiliaries may be disabled, but no one is injured; furthermore, the wire presents a much smaller target than a steam pipe, and is, therefore, less liable to injury from shot. It is always a difficult matter, too, to keep steam and exhaust pipes tight and to prevent leaks at the joints and at water-tight bulkheads.

2d. Injurious heating of living quarters. Steam and exhaust pipes must necessarily run to every auxiliary, and some of the latter, such as the ice machine, anchor hoist, steering engine, ventilators, etc., are in the officers' and men's quarters, or the pipes leading to them must pass through these quarters. The heat of the pipes and engines not only makes the quarters uncomfortable, but it is impossible to prevent more or less oil and dirt around the auxiliaries. In the tropics the heat is often so great that the officers and men cannot sleep below at all. This was the case on a number of our vessels operating in Cuban waters last summer.

3d. Efficiency. Here the contrast is very striking in favor of electricity, surprisingly so to one who has not seen the actual economy figures of steam auxiliaries.

There remain the two important factors of simplicity and reliability to be considered. No one who has had experience with the modern well-designed and well-insulated carbon-brush generator or motor can have any doubt as to its greater simplicity as compared with the steam engine. There are no joints to keep tight, no nuts or bolts to set up, no packing to renew, no cylinders to cut, and only two self-oiling bearings, as compared with a dozen or more oil cups on an engine. In fact, it is difficult to imagine a simpler piece of machinery than the modern dynamo. It seems like a return to elementary principles to discuss such a point; and yet many men aboard ship imagine the dynamo a most complicated affair, simply because they know nothing about electricity and think everything connected with it is mysterious and complex. This feeling is not confined to seafaring men, as we all know.

The question of reliability is a vital one, for no matter what the advantages with respect to safety, economy and simplicity may be, if the electric auxiliary cannot be relied upon at any and all times to do its work it is a failure and must be discarded. It must not only be able to work well under normal and favorable conditions, but it must also be able to stand a certain amount of abuse and neglect. Stress of weather and other conditions, particularly during a war, sometimes play havoc with the established routine of a ship, and the sailor's tools must not only be sound; they must be hardy. The normal conditions aboard ship are not favorable to ordinary electrical apparatus, but this simply means that apparatus for such work must be specially designed and built to meet these conditions. The ordinary motor would not last long under a street car; nevertheless thousands of car motors are built and sold every year which run day in and day out with a remarkably low maintenance account. Similarly apparatus for ship work must be specially insulated, a larger margin of capacity must be allowed, and in exposed places it must be thoroughly enclosed. Several years ago an English manufacturer asked permission to install an electric deck winch on the spar deck of a new cruiser fitting out at Portsmouth. When the captain, who was superintending the fitting out of the ship, saw it he gave orders to have the deck hose turned on the motor for ten minutes, and then to operate the winch. The manufacturer protested and said that the motor was not intended to be abused in that way. "Then take it off the ship," said the captain, "for I cannot guarantee that we will ship no seas during our cruise, and I want that winch ready for service whether we ship seas or not." The captain was quite right; the motor was taken off, and a "rough-and ready" steam motor substituted.

Experience alone is the final test of reliability, and fortunately we have some experience in our navy on which to rely. During the late war all of our regular war vessels were fitted with electric lighting plants, and many of the larger ships were supplied as well with certain electric auxiliaries, such as ventilating fans and ammunition hoists. Two of the "Brooklyn's" turrets were controlled by steam motors and two by electric motors. So far as I have been able to learn, from both official and unofficial sources, all the electrical apparatus on these ships stood the supreme test of battle admirably, and the officers of the "Brooklyn" are enthusiastic over the performance of the electrically controlled turrets. They report that with respect to ease of manipulation and fineness of control there is no comparison, but rather a contrast. This is high praise from competent authority, for the officers refered to had actual command of the turrets in battle, and their judgment is not only unprejudiced and impartial—it is final and conclusive.

It is hardly necessary to say that electric machinery, to be reliable, must have reasonable care and attention from men who know something about it. The same is true of any machinery, and it is bad policy, as well as untrue, to say, as is sometimes said by those who should know better, that an electric motor requires no attention. Cleanliness is very necessary and may be considered as a first essential to successful operation. It is astonishing to see how little has to be done to an electric motor if it is kept scrupulously clean; but this cleaning must be regular and intelligent. From what has been said it may safely be affirmed that electric machinery can be made as reliable on shipboard as any other machinery, and with this in mind we can turn to the question of efficiency, including weight of plant and first cost.

There has been very little data published on the performance of ship auxiliaries, but a valuable contribution to the subject appeared in the February (1898) number of the "Journal of the American Society of Naval Engineers," by P. A. Engineer W. W. White, United States Navy, entitled, "Steam Consumption of the Main and Auxiliary Machinery of the United States Cruiser 'Minneapolis.'"* This vessel, as is generally known, is a first-class, protected cruiser, of about 7500 tons displacement, with three screws (each operated by its own engine) and a trial speed of over 22 knots per hour. She represents the highest type of her class, and is in every way a credit to her designers and builders. She has between thirty and forty steam auxiliaries, and more than 150 separate steam cylinders. Her only electric auxiliaries are the lighting generators and a few small ventilating sets and ammunition hoists. In order to ascer-

*Extracts from paper read before the American Institute of Electrical Engineers, January 25, 1899.

*See The Electrical World, March 26, 1898.

tain the steam consumption of her main engines and auxiliaries Mr. White, who was serving on board the "Minneapolis" at the time as one of her engineers, made a series of careful observations during a run of the vessel of seven days from Gibraltar to League Island, Philadelphia. Indicator cards were taken on all auxiliaries fitted for the purpose (thirty-one in number), and the losses from leakage, condensation and radiation were carefully estimated, and the water evaporated carefully measured. The results obtained are certainly startling.

The average weight of steam used by the main engines per hour was 33,620 pounds, and by the auxiliaries 10,146 pounds. That is, the auxiliaries consumed nearly 25 per cent. of the total coal used. The main engines consumed an average of 20.83 pounds of steam per indicated horse-power per hour, and the auxiliaries an average of 119 pounds per indicated horse-power per hour (the lowest being 55.06 pounds and the highest 318.68 pounds per indicated horse-power per hour). These results are not exceptional; in fact, they are probably better than the average obtained on most warships or merchant vessels. The new British cruiser "Powerful" (14,000 tons displacement) is reported to have used 8300 tons of coal from England to Hong Kong, of which 3400 tons (or over 40 per cent.) were required for the auxiliaries.

Under the most favorable conditions the auxiliaries of a large ship probably consume at least 20 per cent. of the total coal and water used. This is more than twice as great as the consumption in a modern central station, and there is no good reason why as good results should not be obtained afloat as ashore.

Let us assume a required central station capacity for a first-class battleship of 1000 horse-power effective at the motors. The present standard e. m. f. for naval installations is 80 volts, and for the merchant marine about 100 volts. This low voltage was originally adopted on warships on account of the searchlights, which require 50 volts only, and it was desired to introduce as little dead resistance as possible. At this time no motors were, of course, in use, and the electric plant was used for lighting exclusively. Such a voltage is, however, entirely unsuited for a 1000-hp plant. The weight of the distribution system would not only be excessive, but the size and weight of the generators would be prohibitive. The three-wire system or a standard 220 to 2250-volt, two-wire system should be adopted, using the necessary resistance in the searchlight circuits when they are in service; since they require a relatively small percentage of the total plant capacity, and are not regularly in use, this can be done without undue sacrifice.

The generating plant should consist of several units of the same size, so that parts are interchangeable, each unit consisting of a compound vertical engine driving a pair of generators or a single generator, depending upon whether a three-wire or a two-wire system is used. Assuming an efficiency of 82 per cent. for engine and generator and an average line and motor efficiency of 80 per cent., the total efficiency of the system (between the indicated horse-power of the generating engines and the effective horse-power of motors) is 65.6 per cent. In other words, to develop 1000 horse-power at the motors will require 1500 indicated horse-power at the engines, or about 900-kw generator capacity. Six sets of 150 kilowatts each, with one in reserve, would be required. A good compound engine working at approximately full load (and with six units those in actual service can always be operated at or near full load), will require 20 pounds of steam per indicated horse-power per hour. Assuming a total efficiency of the system of 65.6 per cent., as above, it will require about 30 pounds of steam per effective horse-power per hour at the motors. If we allow 25 per cent. margin for losses due to steam leakage, condensation, mechanical friction of gears, etc., we still have an economy of 37.5 pounds per horse-power per hour, as against 119 pounds as shown by the "Minneapolis" test. In this case the auxiliaries tested aggregated 471 horse-power developed, using 56,049 pounds of water per hour. At 8 pounds of water evaporated per pound of coal the coal consumption was 7000 pounds per hour, or 84 tons per day, assuming that this power was required for twenty-four hours. If the water consumption had been at the rate of 37.5 pounds per indicated horse-power per hour, instead of 119 pounds, the coal used per day for these auxiliaries would have been 26.5 tons, a saving of 57.5 tons, or nearly 70 per cent.

It is fair to assume that by the introduction of compound engines and improved mechanical appliances on some of the auxiliaries the average steam consumption can perhaps be reduced to 75 pounds per horse-power per hour; but this is still 100 per cent. in excess of that required for the electric drive. Assuming an average daily use of 800 horse-power effective at the auxiliaries on a first-class battleship at sea, this difference in efficiency means a saving in water used of 360 tons per day, and in coal a saving of 45 tons per day. All steam cylinders connect with the condensers, so that the water used by the auxiliaries is not lost, but is used over and over again, it being necessary to supply only that lost by leakage in the pipes and condensers. The extra pumping duty is large, however. The coal saved, on the other hand, means that with a given coal endurance (or "steaming radius") a vessel can carry from 10 to 20 per cent. less coal; or, expressed in another way, with the same coal capacity she will have from 10 to 20 per cent. greater steaming radius. The average price paid in the navy for coal (including stations in all parts of the world) is probably at least $7 per ton. There is, therefore, in the case assumed a direct saving in running expense of $315 per day for coal alone. It may be argued that a vessel in port does not use her auxiliaries to the same extent that she does at sea, and that, therefore, the comparisons made are misleading. This may be true as to actual savings in pounds of coal and water, or in dollars and cents, but the percentage differences hold true in any case. Furthermore, a ship is built to keep the sea, and her efficiency and usefulness are measured by her performance at sea, and not when incidentally or accidentally in port. Her weights are distributed and apportioned, and her power, speed and "steaming radius" are designed for sea conditions, and it is these conditions alone which should be considered.

The weight and space required for plant are important matters, for a modern steamship, and particularly a war vessel, has every available inch of space and pound of weight carefully allotted; and it is sometimes difficult for the designers to adjust the conflicting elements (which may be equally important) so as to provide for all and still keep within the prescribed limits. The present weight of steam auxiliaries of a first-class battleship, assuming a total capacity at full load of 2000 horse-power as before, is about 200,000 pounds, or 100 tons. If the electric drive is used we must add the weight of the generating plant. The navy specifications limit this weight at present to one-third of a pound per watt of rated capacity. With 1050-kw capacity (six units of 150 kilowatts for service and one for spare) the weight would be 350,000 pounds, or 175 tons. The electric auxiliaries would weigh about the same as steam, or 100 tons, a total of 275 tons as against 100 tons for steam drive. There would be some saving in the wiring, as against steam and exhaust pipes, so that it may be assumed that the electric plant, with the generating sets described, will weigh between two and one-half and three times the steam drive. As an offset, however, we have the saving of 10 to 20 per cent. in coal required for a given steaming radius, which in a ship of this class would amount to between 200 and 400 tons. Furthermore, if in the future a satisfactory steam turbine comparable in economy with the compound engine is developed for marine work, as now seems probable, the weight of the generating plant will be reduced 40 or 50 per cent., and then the electric drive will compare favorably in this respect with steam, and there will still be the saving in weight of coal required for a given endurance.

The space necessary for plant must be considered as one of the vital parts of the ship, and as such it must be located below the protective deck. At first thought it may be said that it will be difficult to find the necessary space, but it must be remembered that the space required for 200 to 400 tons of coal is available, in addition to the space at present allotted for dynamo room, and these combined will certainly be more than sufficient.

The application of the electric drive to the various ship auxiliaries must be carefully studied in each case. The problems involved, however, are not more difficult than many special applications on shore, nor is there anything about them which a competent electrical engineer, with a proper knowledge of sea conditions, is unable to solve. The first cost will undoubtedly be greater than with the steam drive, but the savings in "operating expense," if capltalized, will much more than offset this difference in first cost.

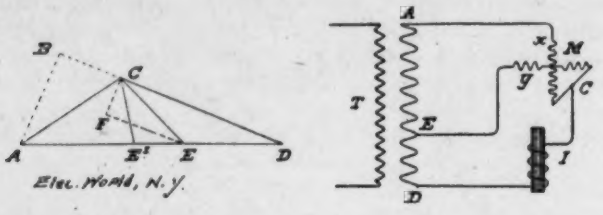
The problem is purely an engineering one and should be approached in a businesslike way. Will the electric drive be equally safe, simple and reliable, and will it be more efficient than the present system of steam drive? This is the question in a nutshell, and I believe that the figures and data which I have presented enable us to answer it most emphatically in the affirmative. Other nations, particularly England, Germany and France, have already introduced the electric drive extensively on their ships, both in the navy and in the merchant marine; and it is earnestly to be hoped that our own navy, with its magnificent ships, officers and men, of whose record we are justly proud, will not lag behind in this important respect.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering

Dynamos, Motors and Transformers.

POLYPHASE FROM SINGLE PHASE CURRENT

Mr. Wagner has devised a method of deriving two or more alternating currents differing in phase from a single alternating current, a brief description of which is given in the N. Y. "Elec. Eng.," Feb. 2. The accompanying illustration, in which *T* is the transformer and *M* the two-phase motor, shows the arrangement, the diagram accompanying it showing the relations between the strengths and phases of the currents, like letters denoting like parts. By this method it is claimed that a number of circuits differing by almost any amount in phase may be derived from two circuits differing slightly in phase by connecting the required circuits between suitable points in the two given circuits.—Wagner. N. Y. "Elec. Eng.," Feb. 2.



FASTENING ARMATURE DISCS TOGETHER.

A correspondent to the "Elek. Anz.," in the issue of Jan. 19, refers to a previously made suggestion to fasten armature discs together by means of water glass. From experience extending over three and a half years, with over ninety motors of various sizes, he finds that if the core is at any time heated more than the normal, say, by a prolonged overload, so that the water glass loses the little moisture which it contains, it will become a powder, thereby losing its effect and enabling the plates to become loose. He therefore does not recommend the method.—"Elek. Anz.," Jan. 19.

REFERENCES.

Electric Generators.—In this continuation of their long serial very full data, accompanied by a double-page insert of drawings, is given of a six-pole, 250-kw generator of one of the latest designs. —Parshall and Hobart. Lond. "Engineering," Jan.. 27.

Design of a Small Engine and Dynamo.—Working drawings of a small engine and dynamo of about 1.5 kilowatts, running at a speed of 1000 revolutions, and designed by the Sturtevant Company. No description is given.—"Amer. Mach.," Feb. 2.

Points to Consider in Accepting a Dynamo.—A short, illustrated article, intended more especially for those who are not electricians, showing how to examine a dynamo before accepting it.—Rice. "The Engineer," Feb. 1.

Induction Motor Diagrams.—The beginning of an article in which he intends to give a full description of the graphical method of explaining the working of induction motors.—Hawkins. Lond. "Elec.," Jan. 27.

Lights and Lighting.

INCLOSED ARCS IN OXYGEN GAS.

Some experiments described in the "Elek. Anz.," Jan. 26, were recently made by Koerting and Mathiesen to examine the effect of the introduction of oxygen in enclosed arc lamps, comparing the results with those of the ordinary and the enclosed lamps. It was thought that an increase of oxygen would lengthen the arc, and the experiments showed this to be the case. The conductivity of the gases in the arc was increased considerably with an increase of the oxygen. The length of the arc was found to depend to a very great extent on the amount of the oxygen supplied to the globe. With the ordinary enclosed lamp there was a falling off in the light of 24 per cent., and the saving in carbons was 20 per cent., showing that the latter is not in the proper proportion to the former. When oxygen was admitted the loss of light was given out for the same energy was only 10 per cent., as compared with a lamp burning in the air, in spite of the fact that the arc was five times as long in the former. The results show that no commercial advantages are gained by increasing the amount of oxygen, as there is not only a loss in light but a five times greater consumption in the carbons, which must be added to the cost of the oxygen. They also claim that the enclosed lamp is not always superior to the ordinary lamp, and they appear to favor the latter. In the first part of the article it is stated that as early as 1846 William Staite called attention to the fact that with enclosed arc lamps the globes should have the smallest possible diameter; they think this early statement of this fact is not generally known.—Koerting and Mathiesen. "Elek. Anz.," Jan. 26.

NERNST LAMP.

A recent lecture was delivered in Dresden by Mr. Fleischhacker on the Nernst lamp, a brief reference to which is given in the "Elek. Anz.," Jan. 22. He compared this invention with that of Jablochkoff patented in 1887, and comes to the conclusion that the fundamental ideas of the Nernst lamp have become public property by the expiration of that patent in 1883. The Nernst lamp, it seems, is not intended to replace the present incandescent lamp, but will take a place between the incandescent and the arc lights, at least at first. In comparison with the present incandescent lamp it has the disadvantages of complications and that it becomes appreciably hotter, therefore increasing the danger by fire. It appears now that the invention was not purchased for $1,250,000, as was originally stated. —Fleischhacker. "Elek. Anz.," Jan. 22.

Power.

150 TON JIB CRANE.

Last year a large electrically operated crane was completed for the Newport News Ship-Building Company, a description of which is given in a paper by Mr. Post, reprinted in abstract, with an illustration, in the N. Y. "Elec. Eng.," Feb. 2. The requirements were to lift and place on board the heaviest single weight liable to occur in the probable development of modern ships. It is a 150-ton revolving derrick, operated electrically throughout. The jib may be raised or lowered and rotated, operating within a diameter of 207 feet and up to a minimum diameter of 88 feet; the maximum load can be handled only within a diameter of 147 feet, but weights of 70 tons can be handled outside of that. The maximum elevations for the two positions of the jib are 118 and 69 feet. The details are described in the paper. It is revolved by a duplicate set of machinery, which consists of a 20-hp railway-series motor driving through a worm and controlled by a series-parallel controller. For the racking movements there are two series motors of 100 horse-power. For the hoist there are two equipments for 75 tons each and a rapid one for 20 tons. Each of these is operated by a 100-hp series motor. The voltage used is 220.—Post. N. Y. "Elec. Eng.," Feb. 2.

REFERENCES.

Project for Utilizing the Power of the Doubs River.—Some estimates for transforming and transmitting the water power from this river, on the boundary between France and Switzerland.—"L'Elec.," Jan. 28.

Electric Utilization of Water Powers.—An abstract of a paper read before the Canadian Electrical Association.—Magie. "Cassiers' Mag.," Feb.

Refuse Destructor at St. Pancras.—An abstract of a report of the combined destructor and lighting plant.—Lond. "Elec. Rev.," Jan. 27.

Traction.

ELECTRIC TRACTION.

Some general observations on electric traction were given by Mr. Parshall in a paper read before the Northern Society of Electrical Engineers in England and reprinted in Lond. "Elec. Eng.," Jan. 27. He claimed that it was a mistake to design traction plants from experience with those for electric lighting; there is a great difference in the nature of the load; in a given plant from three to five times the quantity of electricity will be generated for traction than for lighting, and therefore there may be a greater refinement in the machinery with better arrangements for coal handling, etc. For the best economy heavy fly-wheels are necessary. The speed of the engines is briefly discussed; that of a 1500-kw dynamo, which he designed several years ago, was limited to 75 revolutions, and experience since then has not shown the advisability of increasing this speed; the mechanical and electrical conditions for large direct-connected generators generally coincide in the matter of speed. The transmitting mains, on account of the better load factor, may have a greater cross-section than for lighting loads, which follows from Lord Kelvin's law. The nature of the transmission—that is, whether with continuous current or with multiphase currents and substations—is discussed. The solution depends on the amount of power and the distance, and, in some cases, on the conditions of distribution; where only a very small drop is permissible, as with earth returns, multiphase transmission, with frequent substations, becomes a necessity, while under a less restricted condition continuous transmission would be more economical. Referring to a previous paper, he states that the distance at which multiphase currents become efficient, as compared with continuous, is somewhat less at 500 volts than has been frequently anticipated. When the ratio of the average to the maximum temporary load is comparatively large the distance at which continuous currents become more efficient is increased. In very large installations, in which the ratio of the average to the maximum approaches unity, the distance beyond which the high-tension current is more advantageous, is lessened. What method is most efficient in a particular case cannot be

determined without a knowledge of the nature of the load. One advantage in the use of rotary converter stations is that at constant speeds the machines give constant voltage, regardless of the load or the drop, provided the latter is limited to an economical amount, or to the regulation in the transformer, and such machines can therefore supply both lighting and traction currents. To justify this statement he made some tests recently on 900-kw converters, from which full load could be thrown on or off without any perceptible variation in the continuous-current voltage. In a multiphase system a selection should be made between quarter and three-phase; the latter has the important advantage that only three-quarters of the weight of the copper is required, as compared with either the single or the quarter-phase transmission. There is another advantage when the transformers are delta-connected, as any one of the three can fail and the other two will deliver three-phase current to the rotaries. There is practically no difference in the efficiency or working between three-phase and quarter-phase converters. An engine, to be entirely satisfactory, should not produce by variable velocity a phase displacement of more than 5° per half cycle from that of constant velocity. The transmitting mains should be designed with comparatively small drop, so that the rotaries may work in parallel and can generate a constant voltage with a varying load without too great a phase displacement. If proper precautions are not taken in these matters, rotaries will not operate satisfactorily in parallel, and are likely to give trouble from sparking and variation in voltage. In working with rotaries it is necessary to arrange the mains so that the current in each phase is delivered approximately at the same voltage. The cable should have the same inductance, capacity and resistance in each circuit. The most difficult problem in a large multiphase station is in connection with the switching apparatus. The method of conducting the electricity from the mains to the car is then discussed. The valid objection to the single overhead trolley system is the use of the earth as a return, and trouble is frequent in the United States, where the drop in the earth return is not limited by legislation; little trouble has been experienced in Great Britain, where regulations are in force. With the commercially permissible amount of copper, frequent substations or boosting machines are necessary to bring the voltage drop down to two or three volts, which is generally a safe limit; if it exceeds this trouble from electrolysis will probably occur at some more or less remote date. The double overhead-wire system is complicated and objectionable in appearance, but the three-wire system has great advantages when used with rotary converters, which act both as converters and equalizers, as it is possible to operate over very long distances. Corporations are in general in a better condition to install the conduit system than private companies, as they can borrow money at low rates of interest, and do not have to consider the amortization so much. A mistake is frequently made in underestimating the amount of power that will be required for a system. Considering the Board of Trade rules and the economy of transmission, the limit for a 500-volt, continuous-current station is usually reached at 5000 kw output, and beyond this a multiphase system, with continuous-current distribution, becomes necessary for most economical working. The universal station is a multiphase one, since it can meet every condition with a single type of generating machinery. The discussion which then follows is chiefly of local interest.—Parshall. Lond. "Elec. Eng.," Jan. 27.

HARTFORD.

Some of the methods which have been introduced in the power stations of the Hartford Street Railway Company are illustrated and described in the "St. Ry. Jour.," Feb. One cut shows the method of drying the sand used in the sand boxes on the cars. A cone-shaped receptacle for the sand is built around the iron stack in the loft above the boiler room, and the wet sand is introduced into this hopper by a conveyer operated by an electric motor. The sand is perfectly dry by the time it reaches the spout of the hopper, and by heat which would otherwise be wasted. The company proposes later to keep the sand under air pressure, and conduct it by flexible pipes, or hose, to the cars, so that the sand boxes can be filled without dust and the spilling of sand. Another cut shows a catch consisting of a block of metal fitted in a hole on the top of the old-style car controller to prevent a reversal of the motor by mistake. A semaphore attached to each circuit breaker on the switchboard is illustrated. When the breaker is closed the disc is turned edgewise. and hence is not visible; but when it opens, the disc turns at right angles and indicates to the engineers quickly which circuit breaker has opened. An automatic lubricating system is used for all machinery in its power house. The oil is kept in a fire-proof structure separate from the station and piped to a reservoir in the station, whence it is led to the various engine and generator bearings, after which it is piped to a filter, thence back to the reservoir. The force for driving the oil through the circuits is compressed air.—"St. Ry. Jour.," Feb.

ACCUMULATOR TRACTION IN ITALY.

The statement was recently published that, owing to the unreliability of the accumulators, the trial tests on the line from Milan to Monza, Italy, were not successful. This is denied by Mr. Hensemberger, of Monza, in a short communication published in the "Elek. Anz.," Jan. 22. He states that the trial tests just made have been satisfactory in every way, and gives some brief data concerning the cars. There are 130 cells per car, having a capacity of 330 ampere hours at a one-hour discharge at 260 volts, a total of 85.8 kw hours. The car has four axles, and weighs, complete, with passengers and accumulators, 56 tons, the battery alone weighing 16 tons. There are two series of motors, giving a power of 120 horse-power at times on an up-grade. The total return trip is 30 kilometres. The cars are not yet running regularly. The lighting is done by means of an extra 24-volt battery. At present the batteries are recharged at every return trip.—"Elek. Anz.," Jan. 22.

In a brief communication by the Schuckert Company, in the issue of Jan. 26, it is also stated that the report that the experiment with accumulators on the Milan-Monza line has been a failure, was premature and incorrect. On the first trip some insulation faults developed which had to be repaired, but the subsequent experiments were very satisfactory, and were followed by an order for a third car. The mean speed obtained was 50 kilometres per hour and the maximum 60.—"Elek. Anz.," Jan. 26.

TESTS FOR ELECTROLYSIS IN WATER PIPES.

The water supply of Jersey City is carried across salt marshes in three large cast-iron mains, and for a distance of 2000 feet they are under the tracks of a trolley road. In order to find whether these were being affected by electrolysis, Mr. Knudson made some tests recently, the results of which are published in the "Eng. News," Feb. 2. He found that current was flowing from the tracks to the pipes, the difference of potential between the two being from 2.5 to 15 volts. This he believes to be much too high to consider them free from the destructive action of electrolysis, but the rails were in all cases positive to the mains, and no damage is therefore anticipated along that portion of the pipes; the rails, however, show marked evidence of electrolysis. Tests between the mains showed that the current left the two outside mains and passed to the centre one; the salt water aided this. The indications are that the current flows along the pipes and then passes out where the pipes go through the meadows, not at a single point, but distributed for some distance along the pipes, and from here it finds its way through the meadows to the power station. He does not think the escape of the current is due to any imperfect construction of the railway line, which is said to be built much better than the average. He suggests more frequent tap connections from the return wire to the rails, and that all the rail-bonds and cross-bonds should be examined.—Knudson. "Eng. News," Feb. 2.

MADRID AND BARCELONA.

Well-illustrated descriptions of the electric railways in these Spanish cities is given by Mr. Armstrong in the "St. Ry. Jour.," Feb. The electric equipment of the tramways in these two cities has recently been completed, on American lines; viz., slow-speed, direct-connected engines, water-tube boilers, economizers, cars without top seats, girder rails, etc. The only important particular in which they differ from American roads is in the use of the Dickinson side trolley. In Madrid are two cross-compound engines, with cylinder dimensions 20 inches by 40 inches by 42 inches, each directly connected to a 425-kw generator, and a cooling tower. The equipment of the station at Barcelona is similar to that at Madrid, except that there are three engines and salt water is used for condensing. The poles are generally of the bracket type, and the brackets are not more than 15 inches in length. The feeders are laid underground in cast-iron troughs filled with bitumen. Owing to municipal enactment, distribution from these feeders is made from underground boxes instead of from boxes on the poles, as is usually the case. Each feeder-box is connected with a pilot wire to the power station for testing purposes and for telephone connection. The rail is 6 inches high, weighs 82 pounds, and is supported on concrete. The cars carry forty-four passengers; eighty-five cars are used at Barcelona and forty-five at Madrid.—"St. Ry. Jour.," Feb.

TRACK CONSTRUCTION.

A brief, illustrated description of the track construction on concrete, used in Detroit, is given in the "St. Ry. Jour.," Feb. One company used 100-pound rail on steel ties spaced 5 feet apart; the ties weighed 21 pounds each; the concrete was laid 6 inches below the base of the ties. The other railway, which was built about the same time, used in part wooden ties laid on 6 inch-depth concrete, the concrete being carried up around the base of the ties. The same company also laid rails on longitudinal stringers of concrete, the depth below the rail being 6 inches and the width 15 inches. The rails were then bound together with tie-rods spaced 10 feet apart. From the experience of three years both constructions have been changed, and now both railways use the system illustrated in the article. If soft spots are encountered the construction is carried deeper. The construction has been found perfectly satisfactory when laid on clay subsoil, and about 100 miles of track has been laid in this way during the past three years. With a sand subsoil no kind of concrete sub-construction is recommended. The same company has electrically welded the track near its power station, thereby securing an excellent ground return at that point. About 2 per cent. of the electric welds have broken during the past two years. Where this has occurred the rails have been well bonded.—"St. Ry. Jour.," Feb.

ELECTRIC RAILROADING IN ARGENTINE.

An illustrated description of some of the electric railroads in Argentine is given in the "St. Ry. Jour.," Feb. Buenos Ayres, with 850,000 inhabitants, covers a wide area, and is well supplied with street railways. In the old portion of the city the streets are only 25 feet wide, so that only one car track is allowed. Most of the lines are owned by English capital, and two are equipped with electricity. The longest electric road has a length of 8¼ miles of double track, and connects the old city with the new slaughter

houses in the suburbs, and transports all the meat consumed in the city. The station contains three vertical engines of 450 horse-power each. The piping is in duplicate, and both sets of pipes are in continuous use; in case of an accident to one set the other is run at slightly higher pressure. Forced draft is used for the boilers, and is found very desirable, as sudden loads can be quickly cared for. The engines are run condensing by means of a cooling tower. Two storage batteries are in use, one at the station and one at the farther end of the line; both are equipped with boosters. The track is laid with 9-inch rails, mounted on native, hard wood. The cars have top seats.—"St Ry. Jour.," Feb.

JUNGFRAU RAILWAY.

It appears from some notes in the "Zeit. fuer Elek.," Jan. 22, taken from a Swiss journal, that the company for carrying out this bold project has now been definitely formed, and that the present capital is $800,000, one-half of which is to be used at present for the construction of the first half of the road, a distance of 5.6 kilometres. The capital for the second half is to be obtained in 1901. According to this the whole project is to cost $1,800,000, which is $200,000 less than was estimated in the project of 1896. At present the progress in the tunnel is at the rate of 3.5 metres per day, but with some improved electric drilling machines of the Thomson-Houston system, which are to be introduced, this will be increased to 4 or 4.5 metres. Three new trains have been ordered, each consisting of a locomotive and two cars, which, together with the two present trains, will be able to carry 400 passengers. The new locomotives, which are to be built by the Oerlikon Company, are said to embody great improvements.—"Zeit. fuer Elek.," Jan. 22.

ROADWAY DEPARTMENT OF TRACTION COMPANY, PHILADELPHIA.

A description of the department covering the subject of roadway of the Union Traction Company, of Philadelphia, is given in the "St. Ry. Jour.," Feb., accompanied by a number of illustrations. All designs for frogs, crossings, etc., are made in the company's shops. The diagrams show the methods of laying out curves, and the standard curve switches and mates employed; one for curves of less than 80 feet, the other for curves of a greater radius than this amount. The wearing surface of all the frogs, switches, etc., is manganese steel. For sawing and drilling rails in the shop and on the road the company uses a portable electric drill and saw, consisting of a motor with flexible shaft; the use of the drill is illustrated. For grinding down joints after they have been cast-welded, a portable emery wheel, driven in the same way, is used. The article also describes the method by which the frogs, etc., are cast-welded in the track-yard of the company.—"St. Ry. Jour.," Feb.

DENVER.

A brief, illustrated description of the method of splicing cars used on a railway in Denver is given in the "St. Ry. Jour.," Feb. This company has been splicing some of its old 16-foot body cars, each with a seven-bench open car, to make one car 39 feet over all. The cars are mounted on a framing of two 6-inch I-beams extending the entire length of the car, the beams being joined together by stout oak pieces. The sitting arrangement of the open end of the car is changed, and the only entrance to the car is in the middle. All of the cars have recently been fitted with storm fronts and electric headlights.—"St. Ry. Jour.," Feb.

STANSSTAD-ENGELBERG RAILWAY.

A long, illustrated description of this three-phase line, another description of which was noticed in the "Digest" Jan. 21. At one place there is a crossing of this line with an ordinary trolley line, and where the overhead wires cross they are carried on different levels, the three-phase lines being cut and connected to the lower ends of the two suspended metal frames shaped like a horseshoe, the single trolley wire being secured to the inside of the upper part of this horseshoe. As the cars of the three-phase line contain two current collectors, the current in the three-phase circuit is not broken.—Lond. "Elec.," Jan. 27.

STREET RAILWAY STATISTICS FOR THE UNITED STATES.

A large, double-page table is published in the "St. Ry. Jour.," Feb., containing the statistics for 1897 and 1898 concerning the mileage, number of cars, kinds of railways, and capitalization for each of the States. For 1898 the principal figures for the whole United States are as follows: There are 954 roads (how many of these are electric is not stated); the track mileage of the electric railways is 15,672; the number of motor cars, 36,429, and the number of trailers, 7914. The total track mileage of all the lines is 17,291, and the total number of cars, 54,549. The total capital stock is $922,400,962; the total funded debt is $699,419,932.—"St. Ry. Jour.," Feb.

RAILWAY STATISTICS FOR THE UNITED KINGDOM.

A very large table containing well-filled columns of data concerning the electric railways in the United Kingdom in operation and in progress is published in the form of a supplement to the Lond. "Elec.," Jan. 27. There are 34 lines in operation, 27 under construction and 98 projected, making a total of 154, or an increase of 48 per cent. in the number of working lines over that of the previous year, and of 90 per cent. in the total number of lines. In 1897 the total mileage of those in operation was 140, while at present it exceeds 240, an increase of 71 per cent.—Lond. "Elec.," Jan. 27.

HIGH SPEEDS WITH AUTOMOBILES.

A note in "L'Ind. Elec.," Jan. 25, records some very high speeds recently obtained with two electric vehicles; they are said to be the highest speeds yet reached for short distances. The average for the second kilometre of the run was 70.3 kilometres (42 miles) per hour, which is equal to that of an express train.—"L'Ind. Elec.," Jan. 25.

REFERENCES.

Elevated Road in Chicago.—Some extracts of the recent annual report on the Alley elevated road in Chicago. It includes some operating data, and shows that the electric system is very successful from the financial point of view.—"West. Elec.," Feb. 4.

Cincinnati & Hamilton Railway.—A brief description of this part of a system 100 miles in length. This line is 15 miles, and is operated by two engines of 600 horse-power each.—"St. Ry. Jour.," Feb.

Electric Towing of Canal Boats.—A translation, with the illustrations, of the article noticed in the "Digest" Dec. 31, describing the Galliot systems.—"Sc. Am. Sup.," Feb. 4.

Installations, Systems and Appliances.

SHOREDITCH.

The account of the first complete year's working of this much-talked-of plant, the steam for which is raised mainly by the burning of the refuse, has now been passed by the British Board of Trade, and some extracts from it are published in the Lond. "Elec. Eng.," Jan. 27. The account shows that in acquiring rapidly a handsome balance this station is far ahead of any other municipal plant. At the end of the year some 29,000 lamps of 8 candle power, or their equivalent, were connected. No coal is used in the station until the output reached 300 kilowatts; below this, the energy is all obtained from the refuse. The cost of coal is only 0.29 cents per unit generated. The value of the steam supplied by the destructor is nearly $5000 per year. The total works' cost is a little below two cents per unit, or, including the charge for steam from the destructor, it is only 2.64 cents, which is lower than that of nearly all of the old-established works of London, and is especially low considering that it is for the first year. The net revenue, after deducting interest and repayment of loans, shows a balance of about $15,000. The revenue account is reprinted in tabular form.—Lond. "Elec. Eng.," Jan. 27.

CENTRAL STATION STATISTICS.

The following table, taken from the "American Electrical Directory and Buyers' Manual" for Sept., is published in the "Eng. News," Feb. 2. The table gives merely the totals:

	No. Stations.	Total Arc Lights.	Incandescent Lamps—Direct Current.	Incandescent Lamps—Alternate Current.	Incandescent Lamps—Total.	Engine hp.
Municipal .	334	26,185	61,695	317,970	379,665	69,145
Private	2275	265,708	2,312,221	4,988,231	7,300,452	994,688
Total	2609	291,893	2,373,916	5,306,201	7,680,117	1,063,833

The capital stock of the private stations is $246,319,610.—"Eng. News," Feb. 2.

PLANT AT MOUTIER.

An illustrated description of this plant in the Jura Mountains, in which a water power of about 500 horse-power is used, is published in "L'Ind. Elec.," Jan. 25. The present installation is only for 100 horse-power. The transmission is to a distance of 2.5 kilometres, and the diphase system with three wires is used, as the lighting load predominates over the motor load. The voltage is 2000 and the frequency 50. A direct-coupled Alioth alternator, a description of which is included, is used. The cost of the hydraulic part of the installation was at the rate of $150 per horse-power. Further details are published in "Genie Civil."—"L'Ind. Elec.," Jan. 25.

REFERENCES.

Compound Dynamos as Balances.—Descriptions of several methods of connecting two compound dynamos in series to be used as a balancer on a three-wire circuit. (See also "Digest" Nov. 26.)—Lond. "Elec. Eng.," Jan. 27.

Hotel Plant.—A brief, illustrated description of the new plant at the Hotel Metropole, in Chicago, with which remarkable economies are said to have been obtained.—"West. Elec.," Feb. 4.

Operating Costs of English Stations.—Extracts from the analysis of the operating costs of lighting stations in England, recently noticed in the "Digest."—"Eng. News," Feb. 2.

Three-Phase Plant.—Several explanations of the problem described by Gibson and noticed in the "Digest" last week.—Lond. "Elec. Rev.," Jan. 27.

System of Charging.—A reply to the criticism of Dick, noticed in the "Digest" Jan. 28.—Meynier. "L'Ind. Elec.," Jan. 25.

Wires, Wiring and Conduits.

LONDON–BIRMINGHAM UNDERGROUND TELEPHONE CABLE.

Brief descriptions of the new underground cable which is being laid from London to Birmingham have already been referred to, but some further details and particulars of interest are given in the Lond. "Elec.," Jan. 27, referring chiefly to the method of laying and joining. The cable contains seventy-six wires made up in pairs; the copper conductors are 97 mils in diameter, weighing 150 pounds to the mile, and having a resistance not greater than 5.852 ohms per mile. Each conductor is insulated with wrappings of paper, and there is another strip of paper dividing the two wires of each pair. The "lay" in twisting the pairs is 12 inches, and the pairs are cabled in layers of 1, 6, 12 and 19, and between each layer, as also between the last layer and the lead sheathing, there is a lapping of paper tape. No cotton is used. After it is thoroughly dried it is lead-covered, the diameter over all being 2.5 inches. The insulation of the laid and jointed cable is found to be 28,000 megohms per mile, which reflects great credit on the method of joining. The cable is

drawn into 3-inch cast-iron pipes in lengths of 152 yards. The whole line is 112 miles long, of which 78 is now completed. The cable is kept sealed from the time it leaves the factory until the moment when the joints are made. The latter is done in the usual way, a lead pipe being afterward slipped over the joints; a cut is made in this pipe and heat is applied until a piece of looking-glass indicates that no more moisture is coming off; on a fine dry day heating one hour is sufficient; after this the cut in the pipe is sealed. Test pillars are placed at intervals of 5 miles along the route. No necessity has yet been found for utilizing dry-air circulation for drying the joints,

but arrangements for doing this will be made if necessary. The air can be pumped through 3 miles of cable with a pressure of 36 pounds to the square inch.—Lond. "Elec.," Jan. 27.

A more fully illustrated description, together with the general terms of the specifications and a cross-section of the cable, are given in the Lond. "Elec. Rev.," Jan. 27.

HOUSE WIRING REGULATIONS.

Three papers were recently read before the Institution of Elec. Eng., in London, all of which refer to the want of uniformity in the regulations for house-wiring, the conclusions in all of them being that the time has come when the existing state of things should cease and one set of rules be generally adopted. Brief abstracts of the papers are published in the Lond. "Elec. Rev.," Jan. 27. Compton advocated the adoption of the Institution rules. Pigg criticized the various regulations, and, it seems, intimates that the Institution rules should be used as a basis for a uniform set. Wordingham's paper, which is published in full in the Lond. "Elec. Eng.," Jan. 27, is chiefly of local interest, and includes a description of the system which he introduced in Manchester.—"Elec. Rev." and "Elec. Eng.," Jan. 27.

REFERENCES.

Underwriters' Association.—A reprint of the text of the specifications and rules which the committee of the Underwriters' National Electric Association passed at a recent meeting.—"West. Elec.," Feb. 4.

Electro-Physics and Magnetism.

LIQUID HYDROGEN.

In a recent lecture on liquid hydrogen by Professor Dewar, a number of statements were made, some of which are of interest to electricians. Among these are that there was no appearance of that element being a metal, as Faraday thought it might prove to be. It is not a conductor of electricity. The density is six times less than that of the lightest liquid known. The liquid itself, he is satsfield, is not magnetic, although cotton well soaked with it appeared to be magnetic, probably owing to its being immediately filled with solid oxygen, which is highly magnetic. He showed how vacuum tubes containing a very high vacuum could be easily and simply made by immersing a closed tube in the liquid hydrogen, collecting in a small side tube the frozen gas which was immediately formed in it, and then fusing the junction betwen this and the main tube. The boiling point of liquid hydrogen appears to be 35° absolute temperature. A brief abstract of the lecture is given in Lond. "Elec. Rev.," Jan. 27.

GENERATING ROENTGEN RAYS.

In a short communication by Mr. Rollins to the "Am. Jour. of Sc.," Feb., he gives his opinion of the advance which will be made. He believes it must consist in devising simple means for making the exciting surges harmonics of the rate of vibration which it is desired to produce in the radiant energy. All his experiments are said to point in this direction, and he found it possible to get better results with a small, properly tuned generator than with the largest size improperly adjusted. The rest of his communication refers to articles already noticed in the "Digest."—Rollins. "Am. Jour. of Sc.," Feb.

REFERENCES.

Chemical Action of Magnetism.—A short, illustrated article in which, after briefly reviewing previous researches in this field, he describes experiments which he believes show that magnetism will affect the chemical relations of other bodies besides iron. His experiments seem to have been made with the action on photographic plates. He adds that the nature of the action observed has a resemblance to that of certain light rays.—Jahr. "Elektrochem. Zeit.," Dec.

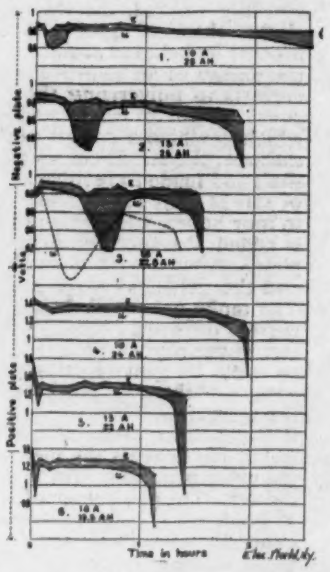
Resistance of Electrolytes in a Metallic Field.—A reprint of a short Academy paper, in which he shows that the resistance of a liquid conductor varies in a magnetic field, although the resistivity of electrolytes is not modified by an electric field.—Bagard. "L'Eclairage Elec.," Jan. 21, and "L'Ind. Elec.," Jan. 25.

Elements of the Earth's Magnetism.—The absolute values for the first of January of this year, for several observatories in France taken from an Academy paper.—Moureaux. "L'Eclairage Elec.," Jan. 21.

Electro-Chemistry and Batteries.

CAPACITIES OF POSITIVE AND NEGATIVE ACCUMULATOR PLATES.

In testing accumulators they are generally considered as a unit, and not, as they should be, a composite consisting of two different plates, each of which behaves differently, and may have a different capacity. In an article by Mr. Schoop, in "L'Ind. Elec.," Jan. 25, he calls attention to this composite nature of the capacity, and shows that it is quite easy to determine with accuracy the individual behavior and properties of the positive and of the negative plates separately. In most of the cells which he tested the end of the discharge was determined by the positive plates, which gave out first, and with several German accumulators he found that the capacity of the negative electrode was about equal to twice that of the positive. Streintz found that in a Planté accumulator the capacity of the peroxidized plate was greater than that of the plate which was reduced. The usual discharge curve indicates by its form which of the electrodes have been the cause of the drop of the voltage. Ordinarily the polarization is more sudden and more intense at the cathode (apparently meaning the spongy lead plate) than at the anode (peroxide plate); if, therefore, the curve drops suddenly, it is probably the negative plate which has given out first, while if the fall is gradual it indicates that probably the positive plate has given out first. Some makers test the individual plates by using an auxiliary electrode of copper, silver or cadmium, and measuring the voltage between it and each of the plates, but this method is not satisfactory, and he therefore devised the following new one, which he says overcomes the objections. Some chemically pure mercury is poured into a small cylindrical, porous cup and on top of this is placed a layer of sulphate of mercury, after which the cup is nearly filled with sulphuric acid of a density of 1.17. A gelatinous electrolyte can be used to make it more convenient to handle, by adding to the acid one-third of its volume of silicate of potash. The porous cup may then be sealed. A platinum wire leads through the cover into the mercury at the bottom, being protected by a glass rod from contact with the acid. When not in use the cup may be kept in another vessel filled with acid. In making the tests this porous cup is placed in the accumulator near the plate to be tested, and the voltage between the platinum wire and each of the plates is then measured, the resulting curves for different charges and discharges being extremely useful and interesting, and will give information useful to the constructor. The changes in an accumulator involve those in the e. m. f., the capacity and the internal resistance, and by means of this auxiliary electrode the variations in these factors may be determined. The adjoining curves were the results obtained in three different discharges at 10, 15 and 18 amperes of the same plate. The curves marked *E* are for the e. m. f. existing between the accumulator plate and the auxiliary electrode, and those marked *u* the corresponding difference of potential during the discharge; they show that the resistance of the plate, which is proportional to the height of the cross-hatched space between the curves, has a numerical value which is greater for the stronger currents, and the variations at the beginning of each curve show the intimate connection between the internal resistance and the diffusion of the acid. (The cause of the curious depressions in some of these curves is not discussed.) A curve for a very thick plate is shown in dotted lines in the third set of curves. The causes of local action are also easily determined in this way.—Schoop. "L'Ind. Elec.," Jan. 25.



(Quite a number of years ago the compiler realized the importance of testing the plates individually, but used a different method, which is simpler, although it may in some cases be not quite as convenient. Two small, well-formed Planté plates were kept in a test glass and connected with a source so as to always keep them fully charged. Whenever the individual plates of the accumulator under charge or discharge were to be tested the corresponding test-plate of the small accumulator was inserted in the large cell and the voltage between it and the other plate was measured with a high-resistance voltmeter. In this way the conditions of the individual

plates of an accumulator could be found at any time, and the results turned out to be quite useful.)

THEORY OF THE LEAD ACCUMULATOR.

A short summary of the recent voluminous publications of Dolezalek, the originals of which have already been referred to in the "Digest," is given in the "Zeit. fuer Elek.," Jan. 22. His conclusions seem to be based on very extended researches and calculations. He comes to the conclusion that the action in a lead accumulator is a completely reversible one, and is simply that both electrodes combine with the sulphuric acid, forming simple lead sulphate. That the e. m. f. can be calculated correctly from this reaction, was shown some years ago by Streintz, in which he showed that the second law of thermo-dynamics must also be considered. Extended measurements have shown that the e. m. f. increases quite rapidly with the concentration of the acid, and Dolezalek has shown that this agrees with his theory of the reaction, as is shown in a table giving the calculated and observed values for different concentrations. The difference between the charging and discharging voltage is therefore due, not to a different process, but to differences in concentration of the acid, which arises in the active mass of the material. The acid set free during charge at both poles can only get out of the pores very slowly, and the concentration of the acid in the material of the electrodes therefore rises. He gives a formula (apparently of no practical value) showing the dependence of the loss of energy on the mechanical construction of the plates, the conductivity of the acid the current and the time. The loss of energy is determined largely by the difference between the charging and the discharging voltage. On closed circuit the concentration of the acid in the electrodes will increase or diminish until the e. m. f. of the local concentration currents has increased so much that the latter, in the same unit of time, will cause as much acid to enter or leave the pores of the plates as is consumed or set free in the same time by the main charging or discharging current, respectively. With an approximately equal charging and discharging current the accumulator will have the maximum efficiency when the acid has its maximum conductivity—that is, contains 30.4 per cent. of the acid or has a density of 1,224. Actual tests by Earle show this maximum for a concentration of 30.8 per cent., thus confirming the theoretical conclusions. A formula is then deduced, which is that the loss of energy is equal to a constant (depending on the construction of the accumulator and the concentration of the acid) times the square of the current times the time. He adds that if this formula is confirmed by practical tests it will no longer be necessary to test an accumulator by different current strengths, as a single measurement will suffice to determine the value of the constant, which is sufficient to thoroughly characterize the accumulator.—"Zeit. fuer Elek.," Jan. 22.

PROCESS FOR EXTRACTING GOLD AND SILVER.

Among the various electrochemical processes for extracting gold and silver from the ores, which are gradually replacing the older and less efficient methods, is the Pelatan-Clerici process, a brief description of which is given by Mr. Spilsbury in "Cassier's Mag.," Feb. The process is being used with great success at the celebrated Republic mine in Washington, the published reports of which for the last three months show a saving of 90 per cent. of the assay values. The extraction processes have now been so developed that deposits containing as little as $3 to $4 per ton are now being successfully worked, the chief improvement being the introduction of electro-chemical processes for dissolving the gold. The present process he believes promises to come into very general use. It is in the nature of an improvement on the regular cyanide process, and consists in pulverizing the ore very fine, mixing it with about an equal weight of water and running it into a tank the bottom of which contains a copper plate covered with mercury, acting as the cathode; the anode consists of iron plates suspended from a vertical shaft and made to revolve so as to act as stirrers. A certain amount of salt is then added and the stirring action is continued for three to four hours, after which the required amount of potassium cyanide is added, the agitation being continued until the extraction is complete. After a certain number of charges the mercury is drawn off and the gold and silver in it is freed by the process of distillation. The tanks are small, being only about 9 feet in diameter, and the current does not exceed 75 to 100 amperes at 8 to 10 volts. The object of the first stirring is to allow the coarser particles of the metal to settle by gravity, thus saving the solvent; it also brightens the surface of the gold particles, which accelerates their combining with the mercury. There is also thought to be a slight decomposition of the sodium chloride, which acts to keep the surface of the mercury clean. He believes the method compares very favorably with any of the other processes now in use, and he discusses its advantages and defects. The percentage of silver saved may not be as great as that of gold, yet it is far in excess of that saved by other processes, and generally exceeds 75 per cent. The consumption of the cyanide is not much more than that used by other processes. Among the defects are the facts that the tanks must necessarily be small, and this also increases the labor cost. The process may be used with advantage as an adjunct to the regular cyanide process. It may be applied to a greater range of ores, including those of a clayey and slimy nature, which are not adapted to percolation filtration methods.—Spilsbury. "Cassiers' Mag.," Feb.

IMPROVED FORM OF PRIMARY BATTERIES.

Lond. "Engineering," Jan. 27, describes briefly some promising modifications in different forms of primary batteries, suggested by Petersen, of Copenhagen. In the Bunsen cell (zinc, sulphuric acid, porous cup, carbon, nitric acid) the sulphuric acid may be replaced by a solution of sodium chloride (common salt), and this will not affect the e. m. f. or the internal resistance, as was proved by experiment; moreover, the zinc need then not be amalgamated. A substitute for the nitric acid is more difficult to find; he suggests chloride of iron. Such a cell has the good properties of the Leclanche cell, is most constant, and allows currents of 1 ampere to be drawn off for hours, the e. m. f. being 1.72 and the internal resistance of an "ordinary-size cell" is 0.3 to 0.4 ohms. The e. m. f. sinks slowly, and finally the porous cup becomes coated with a gray deposit of iron, which may be removed with hydrochloric acid. The same combination, but with a lower chloride of iron and iron electrode in place of the carbon, yielded a constant current of 1.2 amperes at 0.537 volts for seventy-two hours. An emergency cell of high e. m. f., 1.6 volt, can be prepared by separating a zinc and a carbon plate by a slab of wood and immersing them in iron chloride, or, better, red prussiate of potash; a discharge of 1 ampere may be continued for many hours. The internal resistance of Daniell cells may be diminished by using magnesium chloride instead of sulphuric acid; sodium chloride is still better, but the resulting sulphate tends to crystallize, destroying the porous cell. Inside of the porous cup he places a cylinder of sheet lead, perforated above and below, and closed below by copper gauze. When not in use the porous cup should be taken out, and the lead cylinder, with its charge of crystals, should be put into a solution of copper sulphate.—Lond. "Engineering," Jan. 27.

GRAVITY ELECTROLYTIC CAUSTIC SODA PROCESS.

Among the various electrolytic processes for producing caustic soda there are a number in which the separation of the products is effected with the aid of gravity. Among the latest of these is one that has been recently introduced in Bohemia, a brief description of which is given by Mr. Robertson in the Lond. "Elec.," Jan. 27. Before describing it he gives a short account of the principal processes of this kind, the disadvantages in which are claimed to be overcome by the present one. When an alkaline solution undergoes electrolysis, there is a constant passage of hydroxyl ions toward the anode compartment, while the product of the reaction of the cations with the water collects as an alkaline solution around the cathode, generally spreading to the anode when the process is carried too far, and this forms the chlorate, giving rise to injurious secondary reactions. When the alkaline solution has a higher density than the electrolyte and the liquid in the anode compartment, the anode should be arranged at a higher level than the cathode, the difference in density between the two liquids will then separate them. By the introduction of fresh electrolyte above the anode, and the circulation in the direction opposite to that of the ions, the layer formation is not interfered with, and the alkaline liquid can be withdrawn by an overflow pipe. The electrodes are said to be placed side by side at different levels, if necessary. The anode is covered by a bell, which extends below it, and fresh electrolyte is fed into this compartment continuously, while the alkaline lye produced is continuously removed from the cathode compartment, thus maintaining the layer formation of the liquids without the use of a diaphragm. No further description is given. How far the anticipations will be verified in practice remains to be seen.—Robertson. Lond. "Elec.," Jan. 27.

ELECTROPLATING THE HULLS OF VESSELS.

A number of years ago a description was published of the Crane process for electrolytically coating the hulls of iron vessels with copper. In 1895 an ocean-going tug was electroplated in this way, and after being docked recently was examined by several experts, and a report made by Knudson, abstracts of which are given in the N. Y. "Elec. Eng.," Feb. 2. It appears also that a favorable report has been made to the Government by two of its naval constructors. The process is briefly described, and consists essentially in moving a tank along the sides of the vessels, coating it in patches. A vessel 400 feet long, drawing 20 feet of water, and electroplated one-half at a time, would require about eight or nine days, one deposit requiring three days; this would take 55,500 pounds of copper, costing aboot $6000 for the copper alone. The process includes a number of details, which are said to be important. Some voltmeter tests were made by Knudson to determine the difference of potential between the copper coating and the iron hull, and readings were obtained from one-tenth to one-sixth of a volt, which he says is sufficient to cause corrosive action between the two metals, especially if favored by the presence of salt water; the iron was positive to the copper. The surface of the copper after the vessel had been in use for four years without cleaning was found to be in an excellent condition. He considers this method a substantial improvement over the old method of sheathing with wood and then covering with copper sheets; it does not weaken the hull by the use of bolts, and it weighs and costs less. The coating should not be less than one-sixteenth of an inch thick. If well put on and not abused he believes a vessel would be practically secure against corrosive effects due to electrolysis.—N. Y. "Elec. Eng.," Feb. 2.

ELECTROLYTIC HYDROGEN AND OXYGEN.

An abstract, with some data, concerning the process of Schuckert for the electrolytic production of these gases, which is now used commercially with success. The tanks require a current of 200 amperes at a voltage of 2.7 to 2.8, and are composed only of iron and hard rubber, containing 50 to 60 liters of sodium hydrate. From this installation the first cost was found to be about $21,000. At about 90 horse-power or 60 kilowatts, 100 cb. m. of oxygen and 200 of hydrogen are generated every twenty-four hours; the daily operating costs for these quantities of the gases is $32.50. To generate 1 cb. m. of hydrogen by the chemical method with zinc and sulphuric acid, costs 52 cents, while by the electric method, includ-

ing 10 per cent. interest, it is from 16 to 20 cents.—"Elektrochem. Zeit.," Dec.

PRODUCTION OF CHLORINE.

A process for the production of chlorine from ferrous chloride, devised by Hunt and Watson, is described briefly in the "Elektrochem. Zeit.," Dec. The solution is prepared from the corresponding one of sodium or calcium, treated with iron scrap and hydrochloric acid with an excess of iron, until the acid is all neutralized, which requires several days. The solution is then concentrated down to 1.4 and subjected to the action of an electric current. There are two compartments, one containing an alkaline chloride solution and the anode of retort carbon; the other contains the iron solution and the cathode, made of sheet iron, on which the iron is deposited. The density should not fall below 1.2.—Hunt and Watson. "Elektrochem. Zeit.," Dec.

ACCUMULATORS FOR AUTOMOBILES.

Complete tabulated data of the Pisca accumulators, specially constructed for automobiles, is given in "L'Eclairage Elec.," Jan. 21. The object in these cells is not to obtain the greatest output per pound, but to give them a long life. The principal data for a cell containing eleven plates, weighing 18 kg, is as follows: For a discharge of three hours, 2.1 amperes, 4 watts, 6.5 ampere-hours and 12 watt-hours, all per kg of cell complete. For a discharge of 1.5 hours the capacity is reduced to 92 per cent., or for six hours it is increased to 120 per cent.—"L'Eclairage Elec.," Jan. 21.

REFERENCES.

Teaching Electrochemistry.—A list of the subjects and courses at a number of the universities in Germany, accompanied by a statement that there appears to be no college or institution in England that has commenced a regular course of lectures on this subject.—Lond. "Elec. Rev.," Jan. 27.

Present Status of Electrochemistry.—A reprint of a recent paper in which the subject is treated from a technical standpoint. The references to each of the various industries are only quite brief.—Klaudy. "Zeit. fuer Elek.," Jan. 22.

Electricity and the Increasing Importance of Inorganic Chemistry.—An abstract of a German paper of a general character, treating the subject chiefly from a theoretical standpoint.—V. Hoff. N. Y. "Elec. Eng.," Feb. 2.

Electrochemical and Electrometallurgical Industries.—The beginning of a reprint of the articles noticed in the "Digest" Feb. 4.—Kershaw. N. Y. "El'ty," Feb. 8.

Pulvis Accumulator.—Tabular data concerning this French accumulator, which was noticed in the "Digest" Jan. 21.—Lond. "Elec. Rev.," Jan. 27.

Cost of Producing Calcium Carbide.—An abstract of an article on the cost of this process.—"Elektrochem. Zeit.," Dec.

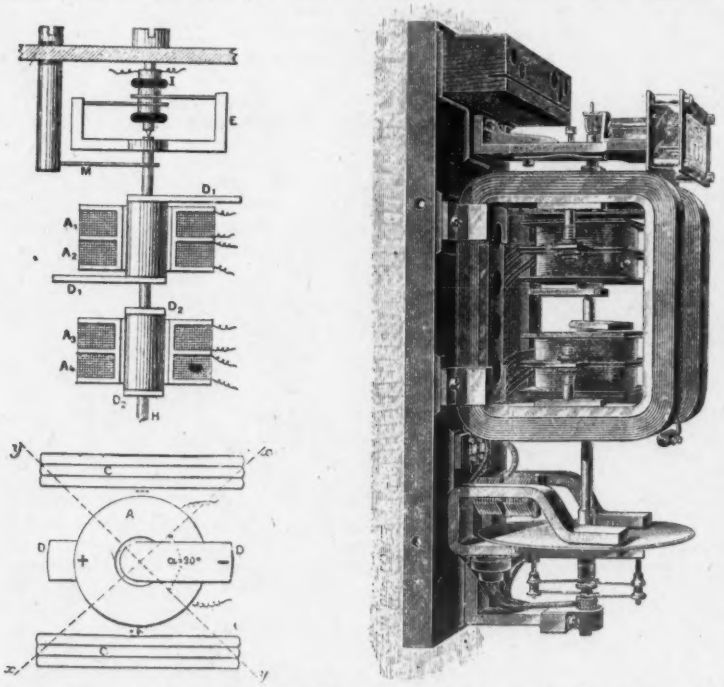
Electrolytic Analyses.—Descriptions of several methods for analyzing alloys.—Arth. "L'Eclairage Elec.," Jan. 21.

Calcium Carbide Furnace.—A brief, illustrated description of the Maxim furnace.—"L'Eclairage Elec.," Jan. 21.

Units, Measurements and Instruments.

CONTINUOUS CURRENT METER.

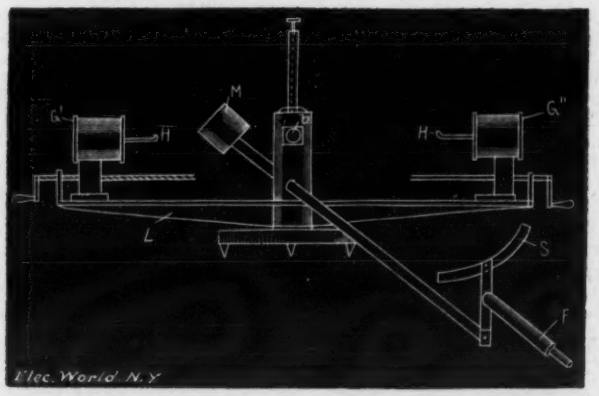
A novel form of meter, characterized by the fact that all of the wire coils are stationary, is described in "L'Ind. Elec.," Jan. 25, and



is known as the Peloux meter; it is claimed to be the only one which has no movable wire. It is a motor-meter in which the angular velocity is proportional at all times to the current. The movable part is connected with the usual copper disc rotating between magnets. Referring to the adjoining illustrations, *C C* are two series coils, between which the revolving part moves; the current to be measured flows through those coils. There are also four other stationary coils, marked *A*, which surround the revolving shaft; they have a high resistance of about 3000 ohms. The revolving shaft contains two pieces of iron, *D*, bent, as shown, like the letter Z. It has a four-part commutator of silver, on which rest four brushes, one for each of the four high-resistance coils, all of which have a common return through the other brush, *M*. By the revolution of the shaft with its iron projections the current is switched successively into the four coils, each coil therefore magnetizing the iron during a quarter of its revolution, and this, together with the magnetism of the series coils, produces a rotation of the shaft. (It will be noticed that the two figures differ somewhat from each other in detail, but the general principle is the same.) Owing to the light weight of the movable part the friction becomes slight, and the moving part is easily balanced; the total absence of moving wires makes the apparatus less delicate; the amount of fine wire used can be greatly increased without increasing the weight of the moving part; moreover, the latter has a very slight inertia, and will therefore correspond quickly to changes in the current; the large amount of wire on the coils enables a strong starting torque to be produced. The loss of current in the shunt circuit is less than 4 watts, and the angular velocity of the moving part at full load is about eighty revolutions per minute. A number of tests were made by "E. H." (apparently the editor), the results of which are given briefly. The meter was intended for a current from 0 to 10 amperes, at about 120 volts. The readings were made by counting the time for a certain number of revolutions. The results show absolute proportion between 2 and 10 amperes, and tests at 120 to 130 volts show that between these limits it is an energy meter, as distinguished from a current meter. The loss in the fine wire is the same as that in the Thomson meter, while that in the series coil is less. The loss in the Peloux meter for 10 amperes is 0.85 volt or 8.5 watts at full load, while with the Thomson meter it is 1 volt and 10 watts.—"L'Ind. Elec.," Jan. 25.

MEASURING THE MAGNETIC PROPERTIES OF SAMPLES.

An apparatus devised by Friese called a differential magnetometer, and which is said to be quite sensitive in its readings, is described in the "Elek Anz.," Jan. 19, with the aid of the accompanying crude drawing. The apparatus is made by a well-known instrument maker in Germany. The object of it is not to measure the absolute value of the magnetic properties of samples, but merely to compare a sample with another of known qualities, and it, therefore, is of use in the numerous cases in which the question arises, whether a certain iron is better or worse than what was guaranteed, or in what way it differs from the material which has already been in use and on which calculations have been based; the apparatus is said to be well adapted for this, as it is very sensitive and shows the slightest changes. Referring to the accompanying outline sketch, it will be seen to consist of two coils mounted near the two ends of a bar, and capable of being moved slightly along the bar. In the middle there is a suspended magnetic needle provided with the usual telescope and scale for making the readings. The whole apparatus is pivoted on its base, so that the bar can be set perpendicularly to the magnetic meridian. This adjustment is made by connecting the two coils in series and passing a current first in one direction and then in the other, and turning the bar until these two deflections are equal. The two coils are then connected so as to oppose each



other, when there should be no deflection; but as the coils are not always alike, the slight deflection is balanced by moving one or the other along the bar with respect to the magnetic needle. After these adjustments the apparatus is ready to be used. The sample is placed in one of the two coils on the support *H*, and if it is fully demagnetized it should have no action on the needle. A current is then sent through both coils, connected differentially—that is, opposed to each other—and the magnetism of the sample will then deflect the needle proportionately. In this way the hysteresis loop can be determined as with any other method, except that the ordinates will be deflections and not lines of force, but as these are proportional to each other, there will be a true proportion between the loss of energy and the hysteresis loop obtained. Previously to this a similar test must be made with the sample whose properties are known, and the two results may then be compared with each other. —"Elek. Anz.," Jan. 19.

CONDENSER.

A new form of condenser devised by Bradley is briefly described and illustrated in the N. Y. "Elec. Eng.," Feb. 2. Two conducting wires are wound on a bobbin, one of them being wrapped with a thread having a low specific inductive capacity, and the several layers are separated so as to leave open places between them. The spaces are then filled with the dielectric, stearate of lead.—Bradley, N. Y. "Elec. Eng.," Feb. 2.

REFERENCES.

New Pentane Standard.—An illustrated description of the 10-cp standard, which has been adopted for testing the gas in London; it is a Vernon-Harcourt lamp.—"L'Ind. Elec.," Jan. 25.

Magnetometer.—A reprint of a short French Academy paper describing, with the aid of an illustration, a simple form of magnetometer.—Guillet. "L'Ind. Elec.," Jan. 25.

Telegraphy, Telephony and Signals.

TELEGRAPH AND TELEPHONE STATISTICS OF THE WORLD.

Statistics for 1896, collected and published by Mr. Webersik, have recently been published, and some of the most interesting information is reprinted in the "Zeit. fuer Elek.," Jan. 22. The following gives those portions which are of general interest:

	Telegraph stations.	Telegraph lines (not wires).	Number of messages.	Number of towns with telephone exchanges.	Number of subscribers and public stations.
Europe	71,780	763,691 km	255,205,000	2,741	384,536
America	31,655	632,760 "	100,257,000	1,444	335,494
Asia	5,983	156,939 "	17,103,000	445	12,731
Australia	3,145	78,400 "	10,362,000	45	6,490
Africa	1,592	56,188 "	8,117,000	30	860
Totals	114,155	1,687,978 km	391,104,000	4,705	740,111

Assuming that the increase in the number of telegraph stations in 1897 and '98 is about 5 per cent., the total number of telegraph stations now is 120,000, which includes the Government, the railroad and the private lines. In relation to the population Australia and Switzerland stand at the head; for every 10,000 population in Australia there are 6.4 and in Switzerland 6.3 telegraph stations. The density of the lines is greatest in Germany and Great Britain, where for every 10 sq. mm. there are 10.6 and 11.8 km of wire, respectively, while in the United States, although it has the largest number of lines and length of wire in the whole world, the number is only 1.7 km. In 1897 the length of wires, including the international cables, was 8,205,307 km, of which over four million is in America; the increase in America was therefore nearly 50 per cent., and in Australia even somewhat more than that. Great Britain has the largest traffic in telegraphs, it being nearly double that of Germany. In relation to the population, it also exceeds all the other countries of the world, as for every 10,000 inhabitants there were 20.6 telegrams, while in the United States it was only 11.4, in Germany 9.7, in Switzerland and Belgium it was 13.2. In the number of telephone stations the United States is far ahead, but only in the absolute numbers, for in relation to the population Canada, Switzerland, Sweden, and Norway take the first place. For every 100,000 inhabitants in Canada there are 9, in Switzerland 8 and in Norway and Sweden 6 towns with telephone stations, while in the United States there are 1.3 or 4.35 telephone stations. In Great Britain the use of the telephone is far below that of the telegraph, as compared with Germany. Taking both telegraph and telephone stations together, the greatest development in proportion to the population is shown to be in Switzerland, where the same is also true of the use of the mail. The total length of all telegraph and telephone wires, including the cables and the railroad lines, in the whole world is said to be 13,250,000 km, of which about 3,000,000 is for telegraphy.—Webersik. "Zeit. fuer Elek.," Jan. 22.

WIRELESS TELEGRAPHY.

In a communication to the Lond. "Elec.," Jan. 27, Mr. Brown states that as a difference exists in the energy received in the receiving circuit of Preece's system, when a simple permanent current was put on the primary current, and when this primary current was rapidly made and broken, there is a better way of signalling, namely, "by taking advantage of the stronger, but slower, varying currents produced in the receiving circuit of such systems when steady currents, broken only by the signaling key, or other currents of low frequency, are sent over the transmitting circuit." A telephone, coherer or other sensitive receiver, can still be used by splitting up the received current into rapid pulsations immediately next to the telephone or other receiver by means of a rapid make-and-break applied to the receiving circuit. For this purpose he uses a light, rapid, trembling bell motion, with an additional insulated contact spring moved by the vibrating armature and operating to rapidly open and close the receiving-line circuit without producing any current in it, the leads bringing the local current being twisted together. The transmitting circuit contains nothing but the battery and signaling key connected to a pair of earth plates. If a coherer is used it is placed as a shunt across an electro-magnet, the extra current from which, however faint, is made and broken in this way. He has made tests with his proposed bare wire and broken cables, and found this to be the best way of working. He has found experimentally that signals formed by short but continuous currents are transmitted by earth co-induction with more efficiency than are rapidly varying ones.—Brown. Lond. "Elec.," Jan. 27.

TELEPHONE SYSTEM IN BERLIN.

A brief extract from recent statistics of the German telegraph department is given in the "Elek. Anz.," Jan. 26. It appears that the telephone plant in Berlin is the largest in the world. At the beginning of 1898 there were 41,410 apparatus in use; there were 40,921 receivers and 32,128 subscribers. The length of the lines was 907 km, and of wires, 75,719, while that of the whole telegraph system of Germany is only 244,311 km. The next largest in Germany is the Exchange at Hamburg, which contains only 29,000 km of wires and nearly 17,000 apparatus. The number of connections in 1897 in Berlin was 182,500,000, and for the whole country 647,000,000; thus about one-third of those in the whole country are in Berlin, and the native of that city therefore communicates 7 to 8 times as much by telephone as the other inhabitants of Germany.—"Elek. Anz.," Jan. 26.

REFERENCES.

Signaling Through a Single Wire.—A brief description of a simple method in which Hertzian waves are used; the description is not clear.—Colquhoun. Lond. "Elec. Eng.," Jan. 27.

Experiments with Hertzian Telegraphy.—A long abstract in French of the recent paper noticed in the "Digest" Sept. 10 and Oct. 1.—Tietz. "L'Eclairage Eec.," Jan. 21.

Experiments in Hertzian Telegraphy.—A reprint of the abstract of Strecker's paper from the Lond. "Elec.," noticed in the "Digest" last week.—N. Y. "El'ty," Feb. 8.

Syracuse Telephone Exchange.—A long, illustrated description of this new exchange, which has just been opened.—Loewenthal. N. Y. "Elec. Eng.," Feb. 2.

Recent Progress in Exchange Work.—A brief abstract from a new edition of a telephone handbook.—Webb. "West. Elec.," Feb. 4.

Miscellaneous.

MANUFACTURING GRAPHITE ARTICLES.

A new method devised by Acheson is briefly described in the N. Y. "Elec. Eng.," Feb. 2. The raw materials are moulded and pressed into the required shape, being mixed with some substance capable of combining with carbon or an oxide capable of being reduced by carbon, as also a suitable combining material. The article is then subjected to a temperature sufficiently high to cause more or less of the carbon to be converted into graphite, the electric furnace being used for this purpose. —Acheson. N. Y. "Elec. Eng.," Feb. 2.

REFERENCES.

International Society of Electricians.—A brief description of this society, whose headquarters are in Paris. The papers read before its meetings are often referred to in the "Digest."—N. Y. "Elec. Rev.," Feb. 8.

Physics and Electrical Engineering in 1898.—A reprint of a short review of the progress during the last year.—Lond. "Elec. Rev.," Jan. 27.

An Improved Form of Photometer.

The cuts presented herewith illustrate a modification of the Queen standard photometer as made for the Fostoria Incandescent Lamp Company. It was designed from suggestions of Mr. Hart, of the Fostoria Company, and manufactured by Queen & Co., of Philadelphia.

The lamp manufacturer is often under contract whereby his lamps are sold at a rate depending upon the results of tests on a certain percentage delivered, and therefore he must be absolutely assured of their uniformity and correctness. But a small amount of time can be placed individually on the lamps in testing them, so the photometer must be possessed of the greatest accuracy and rapidity of measurement. The instrument described herewith, it is stated, embodies these characteristics in the highest degree.

Fig. 1 presents the complete instrument. At the left is a pedestal of iron carrying a stage, screen, and curtain, and supporting one end of the photometer bar. An adjustable lamp support on the stage holds a secondary standard, a 16-cp incandescent lamp. This is standardized by comparison with a pair of certified lamps furnished with the photometer. The pedestal on the right supports the other end of the photometer bar and carries a screen and an automatic rotating socket. The photometer bar carries a metal scale graduated in inverse squares and having the 16 point centrally located. By this arrangement the photometer reads directly in candles when using a 16-cp standard.

The scale is inclined from the vertical so as to be illuminated by the test lamp and render the graduations legible. The photometer carriage has a screen of the Lummer-Brodhun type, an optical screen of great accuracy. When so desired either a Bunsen or Leeson screen may be substituted.

The two rheostats below the photometer bar are for controlling the potential on the standard and test lamps, respectively. They have each about 900 steps, and permit of so small a variation of the candle power or potential as to be imperceptible on the most sensitive voltmeter. The rotating socket supported by the right pedestal is more clearly shown in Fig. 2. The main driving shaft, *A*, is hollow and journaled in a step *U*. It has attached to it a pulley *D* driven

from some power shaft and a friction-driving pulley *B*. This shaft runs at 180 revolutions per minute. Within this shaft is a central one, *E*, carrying a plate, *C*, and the screen *F*. Upon the plate *C* are mounted two rotating sockets *G*, *H*. They have journals swung from centres at *X*, and adjustable boxes at the bottom. Spring plugs keep a suitable pressure between the friction pulleys, *B*, *I*, and *I*. Collecting rings and brushes carry the current to the lamp. At *J* is a lever which engages in the plate *C* preventing it from moving. Under this condition the main shaft *A*, which is continuously rotating, will cause both lamps to revolve about their own axes at 180 revolutions per minute. If, however, the lever *J* is momentarily released, the lamps will revolve about the axis of the main shaft and one replace the other. At *K* is a release, which attaches to a pedal below. Depressing this throws over the shaft of the rotating socket which happens to be there, releasing the pulley *I* from the driving pulley, and at the same time stopping the lamp.

The operation is then as follows: When the operator at the photometer has tested the lamp *Y* the operator at the socket trips the lever, *J*, and the lamps exchange places. In so doing they exchange brushes, and, therefore, circuits. This construction is to permit of having lamp at *Y* on normal voltage and lamp at *Z* on low voltage. By this arrangement the operator, in adjusting lamp at *Z* is not annoyed by a strong light. After exchanging the lamps the operator depresses pedal and by means of the release *K* stops lamp *Z*. It is then removed and another substituted. Releasing the pedal starts the lamp rotating slowly or fast as may be desired. If not running truly it may be pressed to one side, and it will stay where it is placed. This is accomplished by using a special socket *N*. It is adapted to take lamps without base, and has fluted contacts to secure a proper adjustment of the lamp terminals. When the lamp runs truly the lever *J* may be tripped, exchanging the positions of the two lamps, as before. The apparatus is well made, serviceable and quite automatic, enabling lamps to be tested with the greatest accuracy and facility.

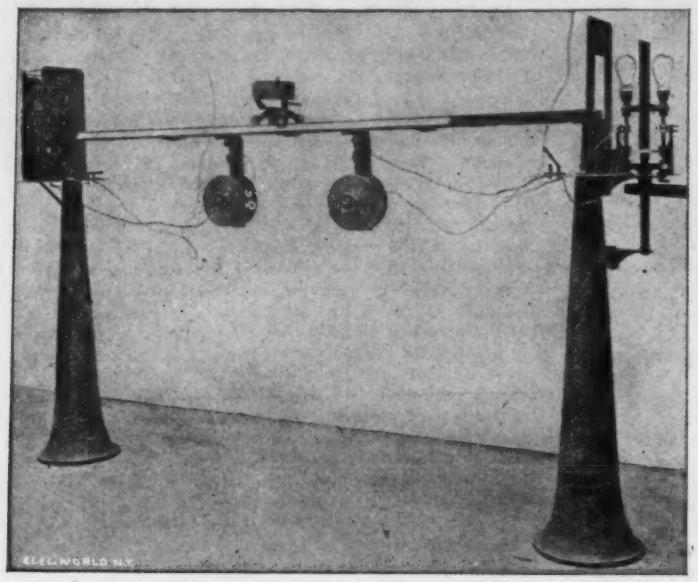


FIG. 1.—PHOTOMETER COMPLETE.

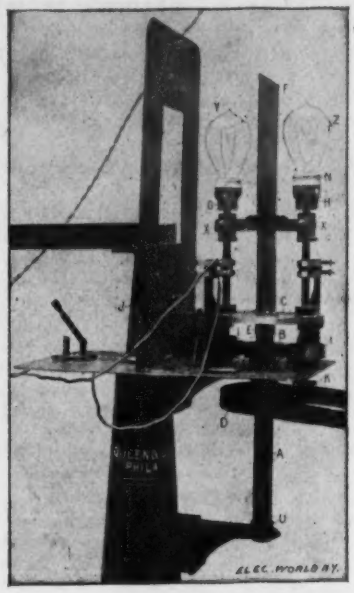


FIG. 2.—THE ROTATING SOCKET.

ENGINEERING SOCIETY LIBRARY, UNIVERSITY OF MICHIGAN

A New Electric Delivery Wagon.

The latest production of the Pope Manufacturing Company in electric vehicles is a delivery wagon, illustrated herewith and intended for all classes of city and suburban delivery service where the loads to be carried, including driver and delivery boy, are not in excess of 1300 pounds. The main idea in design has been the construction of a standard running gear and electrical equipment, complete, adaptable to any form of delivery wagon body the particular business of the customer may demand, and strong and powerful enough to furnish the required mileage over rough city pavements and such grades as are apt to be met in town. The illustrations show the application of this gear to a solidly and handsomely built type of large dry goods delivery wagon.

The motor used is 4 kilowatts, 75 volts, and gives 84 per cent. efficiency at its normal rating. Its behavior under overloads is shown by the efficiency of 78 per cent. actually obtained by brake test at 150 per cent. overload. It is spring-suspended to the running frame and geared to the rear wheels by a single reduction. The body is suspended at the rear by full platform springs, and at the forward end by a double transverse spring. This spring suspension gives highly satisfactory results upon vehicles of this class, allowing the easiest possible riding movement of the body under all conditions. Simplicity is attained by dispensing with the usual reach style of frame, the longitudinal rigidity of the front axle being obtained by jack-bolts or struts, which are fastened to the body.

This carriage has the usual minor features in connection with control and operation which has distinguished the Pope vehicles in the past for convenience and simplicity. Long, plain bearings are used and unquestionably represent the best practice on wagons of this size from a standpoint of efficiency, to say nothing of the simplicity and durability introduced by their use. The vehicle is fitted with wooden wheels, twelve 1⅞-inch spokes in the front set and fourteen in the rear. Standard Kelly 2½-inch tires are employed, a solid rubber tire of this description yielding the most economical results on hard pavements. The driving wheels are 42 inches and the front wheels 36 inches in diameter. The space allotted to the batteries, it will be observed, is not only entirely separate and shut off from the main carrying compartment, but is so arranged that a plain, unobstructed floor space is obtained for the goods. The weight of this vehicle, complete with batteries, is 3900 pounds. The batteries are in four groups, a total weight of 1450 pounds. It is designed for a load of 1000 pounds, exclusive of the weight of two men on the driver's seat, a mileage of 25 and a speed of 10.5 miles per hour on the level. The first experimental wagon of this type built by the Pope Company showed a consumption of 54 watt-hours per 100 pounds per mile at a speed of 11.7 miles per hour on a level road, which is a very creditable performance. Allowing an efficiency of 60 per cent. in the batteries, this would call for 11.7 kw hours to recuperate the carriage after a 25-mile run loaded to its full capacity.

DELIVERY WAGON—REAR VIEW.

SIDE VIEW.

THE BATTERY COMPARTMENT.

NEWS OF THE WEEK

Financial Intelligence.

THE EMPIRE CITY SUBWAY COMPANY, LIMITED, of New York City, has increased its capital stock of $1,500,000 to $1,700,000. The amount of capital of the corporation actually paid in is $1,424,000.

BROOKLYN EDISON SECURITIES LISTED.—Among the securities listed on the New York Stock Exchange on February 8 were $2,000,000 first mortgage consolidated gold bonds of the Edison Electric Illuminating Company, of Brooklyn.

GENERAL ELECTRIC'S ACCUMULATED DIVIDENDS.—At a meeting in New York on February 10 of the directors of the General Electric Company a distribution on the preferred stock of $19.05⅗ was declared. This completes the accumulated dividend payments. The books will close at 3 p.m. February 21, and be reopened on March 10.

INCREASE OF STOCK AUTHORIZED.—The stockholders of the Brooklyn Rapid Transit Company, at a special meeting on February 11, authorized, by a unanimous vote, an increase in the capital stock from $20,000,000 to $45,000,000. About $9,000,000 of the increased capital will be used in taking up the holdings in the Nassau Electric Railroad recently secured, and the remainder will be held in the treasury for the further proposed expansion of the Rapid Transit system, which is said to include the acquisition of the Coney Island and Brooklyn surface road and the two elevated roads.

ELECTRIC STORAGE BATTERY ABOVE PAR.—During the past week the principal feature of the Philadelphia stock market was the remarkable advance in the price of the stock of the Electric Storage Battery Company. The common stock sold on February 10 at 104. About a year and a half ago the stock could have been bought at 19. It is reported that a large interest in the company has been acquired by Messrs. Widener and Elkins, of Philadelphia, and other gentlemen who are associated with them in the traction interests of that city and other cities, including the Metropolitan Strreet Railway Company, of New York. It is stated that the latter company recently made a million dollar contract for storage batteries, and that the Electric Storage Battery Company is figuring upon a contract for the Manhattan Elevated Railway Company, of New York.

Special Correspondence.

New York Notes.

PROPOSED MUNICIPAL CONTROL OF THE SUBWAYS.—It is reported that an effort will be made to secure the passage by the Legislature of an act to place all the electrical subways in this city under municipal control. Mr. H. S. Kearney, Commissioner of Public Buildings, Lighting and Supplies, however, does not think that the city would derive any advantage from municipal control, since it now has the free use of the subways for its police and fire-alarm wires. It has been intimated that the object of the proposed act is to enable the new telephone company to run its wires in the conduits.

ANOTHER ELECTRIC LIGHT DEAL REPORTED.—It was reported on Friday last that plans were about completed for the sale of the stock of the Kings County Electric Light & Power Company to the New York Gas and Electric Light, Heat & Power Company. The latter concern has, as was stated in THE ELECTRICAL WORLD of January 28, virtually obtained control of the Edison Electric Illuminating Company, of New York, and other lighting companies of this city, and it has been stated that the object of the company is to control all of the electric lighting and power interests in Greater New York. It is said that the plans of the new deal contemplate an exchange of stock on the basis of about two shares of preferred stock of the New York Company for one share of stock of the Kings County Company.

DISEASE GERMS IN TELEPHONES.—The Board of Health of this city is making an investigation to determine if public telephones are centres for the distribution of disease germs, but as yet no report of results has been made. The modus operandi of the investigation consists in rubbing the parts of the suspected instruments with absorbent cotton, which is submitted to the bacteriological laboratory for examination. It is stated that a private investigation of this character was conducted in 1894, and the results were such as to warrant the belief that telephone instruments were probable media for the spread of disease in the manner above indicated. To say the least some of the instruments in use are not in an over-cleanly condition and, apart from the danger of spread of disease, a thorough cleaning would do them no harm.

AN ELECTRIC-LIGHT STATION AND A BOARDING HOUSE.—Sarah H. Bly, who keeps a boarding house at 33 West Twenty-sixth Street, has brought an action in the Supreme Court against the Edison Electric Illuminating Company to recover $18,000 damages to her business by the operation of the Twenty-sixth Street station of the company. She says that the operating machinery shakes her house so that her boarders cannot sleep, and that since 1892 she has lost boarders or had to reduce her rates to the extent of a loss of $18,000. One boarder, of a scientific turn of mind, testified that she ascertained the extent of the vibrations by sticking a hatpin in a pincushion and placing an inverted thimble on the hatpin. Just how trustworthy the judge considered this test was not learned.

AUTOMOBILE NIGHT OF THE NEW YORK ELECTRICAL SOCIETY.—On Wednesday evening, February 15, the New York Electrical Society held a meeting at the station of the Electric Vehicle Company. Mr. G. Herbert Condict, chief engineer of the company, was to have addressed the meeting, but was unable to reach New York from Washington owing to the storm. Those attending were escorted over the whole station and watched with interest the operation of removing and replacing the batteries in the vehicles, the station being unusually busy, owing to the heavy snowfall in the streets, requiring frequent renewal of batteries as well as increasing the demand for the vehicles. The members of the society were, as a rule, astonished at the growth of this brand-new industry. The company has already outgrown its quarters at this station, which was described in THE ELECTRICAL WORLD of September 3, 1898, and has leased the whole of a four-story building with 100-foot frontage on Forty-second Street, just east of Third Avenue. To this building will be moved the general offices as well as those of the engineering department and the shops for the erection, assemblage and repair of vehicles, which will be greatly enlarged with the view of actual construction of complete vehicles *de novo*. Provision will also be made for the experimental work of the engineering department, an extensive paint shop will be equipped, etc. The company will also, as was recently noticed in these columns, establish two other stations, each designed for 100 vehicles, and now contemplates entering the delivery-wagon field in a similar manner—that is, establishing stations each fitted for the running of a large number of vehicles, which will be owned, maintained, stabled and charged by the company, and leased out to those desiring to use them. The Electric Vehicle Company now has eighty-four vehicles in commission, some sixty being running, the others being hansoms, for which there is slight demand in inclement winter weather. It has practically given up what is known as "hacking," all its vehicles in service being required by regular customers and "station calls."

THE EFFECT OF THE STORM ON THE LOCAL ELECTRIC RAILWAY SYSTEMS.—The great snowstorm, starting on the night of February 11 and lasting until the morning of Tuesday, February 14, again shut down the operation of the open-conduit electric lines in this city, as did the storm of Thanksgiving last. Blame can hardly be attached, however, to the electrical peculiarities of the open-conduit system, as the storm obstructed the overhead trolley lines even more than it did the former, and the steam railway lines perhaps more than either. The fall of snow was some 15 inches, falling upon a previous fall of 8 inches, which had not been removed from the streets beside the tracks. It was a fine, dry snow, accompanied by a high wind, which drifted it heavily. The Metropolitan Street Railway Company has put into service since the severe storm of last November some forty powerful electrical sweepers, and a few shear plows. These were kept in continuous service, and cars were largely kept off the tracks to avoid obstructing the sweepers. Previous storms and the prolonged, intense cold wave had, however, exhausted the men, and the work of fighting the storm was not as vigorous as it would otherwise have been. The liberal use of salt at the switches and crossings which wrought so much havoc at the time of the Thanksgiving storm by burning out the plows, due to the salty water, was conspicuous by its absence. Brooms and bonfires were resorted to instead. The lines were practically all shut down from Sunday night until Tuesday morning, traffic being allowed to seek the elevated roads and the cable lines, the latter again proving their superiority due to the independence of their tractive effort from frictional adhesion between the wheels and the rails. Even when the tracks were opened but few cars were run, as the tracks gave the only channel for trucks and all other horse-drawn vehicles, the remainder of the streets being banked to a depth of about 3 to 6 feet with snow. The Metropolitan Company made no very strenuous efforts to run many cars, as it feared a coal famine at its temporary power stations, which are not equipped with coal-storage capacity sufficient to tide them over a blockade, and to which coal must be brought by horse-drawn carts, an impossibility when the streets are so badly obstructed.

Chicago Notes.

PERSONAL.—Messrs. L. Snyder and J. P. Hutchings, president and secretary, respectively, of the Kokomo Telephone & Electrical Manufacturing Company, Kokomo, Ind., were in Chicago last week. Both gentlemen were pleased with the business prospects of their company. They state that their factory is now running to its fullest capacity.

THE CHICAGO ELECTRIC TRACTION COMPANY, which operates a storage-battery line about 12 miles in length, running from Sixty-third Street and South Park Avenue to Blue Island, has issued its annual report for the year 1898. The report shows an increase in receipts of 50 per cent. during the last year as compared with 1897. The receipts per car per day were $16.82, and the expenses per car per day were $14.61. The receipts per car-mile were 10 cents, and the expenses per car-mile 8.7 cents. The power-house records show a total operating and maintenance cost per kw hour of $0.0097. The battery expense per car-mile was $0.00758, which constituted a trifle less than 9 per cent. of the total cost of operating and maintaining the road. An experience of more than two years shows that the average mileage for each car battery is 23,000 miles, after which amount of service the positive plates had to be renewed. The new batteries run 22 miles on one charge, but after the cells begin to show the effects of service the batteries are renewed on every 11 miles' run. The average record for the year shows 1.65 kilowatts at the power-

house switchboard for each car-mile of service. The company has decided to lay a single-track extension from Blue Island to Harvey, Ill., a distance of 6 miles. The work will be undertaken in the spring.

THE ANNUAL REPORT of President Carter, of the South Side Elevated Railroad Company, shows net earnings for 1898 of $295,944, as compared with $151,943 in eleven months of 1897. After paying $22,500 of bond interest there remained a surplus of $272,444, equal to 2 2-5 per cent. on the capital stock. The electrical equipment was in complete operation only for the last six months of the year, when the net earnings were $196,933. Deducting six months' bond interest, there remained $180,058, equal to dividends at the rate of 3½ per cent. a year. The report states that the directors will be able to make dividends from current earnings in the near future. The earnings for the last year will go toward improving the capacity of the road and meeting the demands of the public for increased traffic facilities. The daily average of the passenger traffic was 51,771, against 36,525 per day the year previous. During the months of October, November and December, 1898, when the line was operated entirely by electricity, the cost of operation was 57 per cent., including the Loop rental and all expenses, except the interest charge. While expenses have been decreasing, the gross earnings have been steadily increasing. The cost of operation for the entire year was 69.8 per cent. This includes the Loop rental of one-half a cent. per passenger and the company's share of the cost of operating the Loop. The electrical plant has been in constant operation since July last, and has never failed to respond to any demands for power. The cost did not exceed the original estimate, and the building is nearly 50 per cent. larger than was originally estimated upon. The yearly output is at the rate of 11,000,000 kw hours, instead of 9,000,000, as originally estimated. The directors have decided to increase the power nearly .50 per cent. for use next winter. President Carter states that the directors believe that the Sprague multiple-unit system, which is now in operation on the line, has fulfilled expectations. Exhaustive tests have proved the economy of rapid acceleration and long coasting. A schedule speed of 15 miles per hour is easily maintained, and time lost is easily made up. It is possible to increase the speed to 20 miles an hour. The reliability of the equipment has been fully tested during the winter, when 150 cars were in daily operation for many weeks. Although the electrical operation has not been conducted long enough to determine definitely the cost of maintenance, sufficient data have been obtained to confidently state that it will be as low as any other line giving equivalent service, and lower than many surface lines with 18-foot, single-truck cars. Referring to the storage-battery equipment, President Carter's report states that these batteries have greatly reduced the fluctuations in the power supply. The batteries are charged at time of light traffic and discharged at times of heavy traffic, thus equalizing the demand on the power-house equipment. The months of November and December, 1897 and 1898, it should be stated in connection with the foregoing, are the first strictly comparative months. The following table shows the comparative results of operation during these two months each year. (a) Ratio of expenses to earnings, including "Loop" rental, taxes and licenses. (b) Ratio of expenses to earnings, excluding "Loop" rental, but including taxes and licenses. (c) Net earnings.

	a.	b.	c.
November, '97, steam	87.3	77.7	$10,603.80
" '98, electric	57.3	47.7	39,448.56
December, '97, steam	83.6	73.8	14,691.69
" '98, electric	55.0	45.4	45,355.68

Including the Loop, the length of track operated is 19.44 miles. In 1897 this was operated entirely by steam, and in 1898 entirely by the Sprague multiple-unit system. In addition to all Loop expenses, there is a rental equal to 10 per cent. on the gross passenger receipts of the road. This should be considered really as an interest charge, not as an operative expense.

ST. LOUIS NOTES.

INSULATING WORKS BURNED.—The American Insulating Material Works here were destroyed by fire February 4. The property was almost entirely consumed, entailing a loss of $15,000.

SALE ORDERED.—The People's Railway will be sold to the highest bidder to satisfy the claims of third mortgage bond-holders, who have been clamoring for the sale for several months. The company is making a desperate fight to prevent the sale.

WORK WAS COMMENCED on February 7 upon the Wellston Creve Calm Lake & St. Charles Electric Railway. The company has a franchise to construct a double track line from the city limits to the Missouri River, and has filed all the necessary bonds.

NEW STREET RAILWAY LINES.—It is reported that Brown Brothers propose to build a number of lines for which franchises were secured under the Central Traction Company's ordinance. It is said that the construction of these roads will be begun in the spring.

A NEW COUNTY FRANCHISE.—A petition was filed in the St. Louis County Court at Clayton this week by J. T. Donovan, John T. McDermott, Michael Hammel, Jos. E. McGinnis and H. J. Webber under the corporate name of the Maplewood & Jefferson Barracks Railroad Company, asking for a franchise to construct and operate a double track electric street railway line from Maplewood to Jefferson Barracks. The company agrees to begin work within one year after the approval of the franchise, and to complete the entire line within five years.

THE VINCENNES-EAST ST. LOUIS ELECTRIC ROAD.—This road will be built by the Wabash & Mississippi Construction Company. The company has been incorporated for the purpose of building an electric line from Vincennes, Ind., to East St. Louis, and it will be the longest electric line in the world. None of the stock is for sale. The company will have to compete with the B. & O. S. W. It proposes to cut the rates in two and make good profits. Work will be begun in the spring, and will connect Vincennes and East St. Louis by next fall.

PACIFIC COAST NOTES.

THE PACIFIC COAST AGENCY of the Fort Wayne Electric Corporation, Fort Wayne, Ind., has been moved to 35 Second Street, San Francisco.

TELEPHONE IN SKAGWAY.—Skagway, Alaska, will have a telephone exchange, if the Seattle man who is trying to obtain a franchise from the City Council is successful.

THE GAMEWELL COMPANY has just completed a fire-alarm telegraph system in Vallejo, Cal., where there are sixteen non-interfering boxes. The engine houses are supplied with the new punching registers and the latest types of Gamewell apparatus.

CALIFORNIA TO HAVE AUTO-TRUCKS.—An omnibus system will be put into operation in Los Angeles, Cal., and, later, auto-trucks will be introduced into San Francisco by a company composed principally of New York and Chicago capitalists. The hills of San Francisco will furnish a severe testing ground for automobiles.

CONSOLIDATION OF RAILWAYS IN TACOMA.—It is reported that the street railway systems of Tacoma, Wash., are about to be consolidated. A company controlled by Eastern capitalists, and having a capital stock of $2,000,000, has been organized. Its objects are to operate electric and cable cars and to furnish power to manufacturers. It is said that among those interested are representatives of J. P. Morgan & Co., New York; the Northern Pacific Railroad Company, and the Oregon Railway & Navigation Company.

MR. A. J. COFFEE, the new Pacific Coast manager for the Gamewell Fire-Alarm Telegraph Company, reports that a contract has just been signed for the remodeling of the Los Angeles (Cal.) system. Apparatus for a 24-circuit central station will be installed. There will two charging boards of twelve circuits each, and a working board having twenty-four circuits controlled by it. A complete new storage battery of 700 chloride cells will be installed, and the central station will be remodeled. The entire plant, when completed, will be the finest of its kind on the coast.

FRENCH NOTES.

TELEPHONIC COMMUNICATION WITH GERMANY.—The Belgian-German telephone lines have been opened, and at prices which seem ridiculously cheap. A royal order has been issued in Belgium, fixing the prices for communication between the Belgian systems of Antwerp, Brussels, Liège and Verviers on the one hand and the German systems of Frankfort-on-the-Main, Höchat, Hainault and Hoffenbach, on the other, at 75 cents for three-minutes' conversation for ordinary messages and $2.25 for hurry messages. The price is cheap enough, but can it be expected that "hello" girls will really hurry, especially with Belgian girls at one end of the line and German at the other?

THE MOVABLE SIDEWALK FOR THE EXPOSITION OF 1900.—Passenger transportation at the Exposition of 1900 is to be carried on by a railway and a moveable sidewalk, using electricity as the motive power. A competitive contest for plans and bids for the construction of the apparatus was instituted by the Minister of Commerce, and the examining board finally decided for the proposals made by M. de Mocomble. From the Esplanade des Invalides to the Champ de Mars traffic will be carried on a single-rail railway, and the return travel will be on a moving walk having two platforms, running at different speeds. In M. de Mocomble's plans motion is to be communicated to each platform through a single rail jointed every 13 feet and running on stationary rollers carried on a metal frame work. These rolls have no end play, but are capable of vertical motion to enable the tractive effort to be adjusted. The motors as well as the rolls are stationary. In June, 1898, when the plans were under consideration, the committee requested M. de Mocomble to have ready for testing within six months a model of his apparatus running in a circle of 1000 to 1150 feet diameter. These tests have just been concluded at a place near St. Ouen on the Seine. Built in the form of a circle of about 1000 feet diameter is a frame work supporting two rails. A platform, made in sections, is supported by wheels running on these rails. Just below it and to one side is a second platform similar to the first. Each carries a jointed rail which rolls on rollers mounted in pairs on the same shaft. Being of different diameters, the smaller diameter under the side platform, they communicate different speeds to the two platforms, one moving at a rate of 5 miles per hour, and the other at 2½ miles. Twenty-eight three-phase motors were used on this installation to drive the rolls. They were coupled in groups of four in series on 212 volts. The rate of alternations used was 25 periods per second. The power was furnished from a neighboring central station. The method of starting up was rather unusual. All connections were made and all switches closed, then the engine was started up very slowly, and everything brought gradually and simultaneously up to speed. The tests were considered very satisfactory.

ELECTRIC TRACTION ON CANALS.—"Electric Towing for Boats on Rivers and Canals in Belgium" was the subject of a note published in the "Electricien" of July 19, 1898. The expectations and hopes which were then aired have now become solid facts. The General Electric Canal Traction Company was incorporated in Brussels on November 24, 1898, and will put life into this industry. The franchise of this company is for thirty years, and the nominal capital is $300,000. It is really more of a French than a Belgian company, 10,250 of the 12,000 shares being taken up in France. This company expects to cover a very large field; it proposes to carry on the business of boat haulage in all countries, and by the size of all forms of traction it proposes also to carry on the business of producing, transmitting and utilizing electricity for its own enterprises and for those of others as well. The company, controlled by the firm of Denesse, Michel Gaillot et Papot, known as the General Electric Traction Company, for river routes, having an office at Paris, No. 19 Boulevard Montmartre, has been absorbed by the new company, to whom it has sold all its patents for electric towing on rivers, covering the territory of Belgium and Holland, the colonies attached to these countries and the Congo Free State. The property consists of seven patents on traction and an eighth on an air carburetting machine, for producing a supply for use in gas

motors and re-carburetting the exhaust gases. The price paid to Messrs. Denesse, Gaillot et Papot is $360 per kilometre of navigable route using their system in Belgium and elsewhere. In addition, they receive 3000 shares of the capital stock and 15,000 shares of the bonus fund. The administrative board is made up of the following gentlemen: the Baron Floride van Loo, of Ghent; Denesse, of Paris; Léon Gérard, of Brussels, directors; Dautaert, of Brussels, and the Baron de Peelaert, of Ghent, commissaires. The Belgian electrical engineers are well represented in this company in the person of M. Léon Gérard. This company has already obtained a franchise for the Brussels-Charleroi Canal, which will bring in income at once. They are treating for other franchises, among them the Ghent-Terneuzen Canal, which we cannot think will pay anything like as well as the Brussels-Charleroi Canal.

ANNUAL PUBLIC MEETING OF THE PARIS ACADEMY OF SCIENCES.—During this meeting an award of the Henry Wilde prize was made. At a meeting held on July 12, 1897, Mr. Henry Wilde presented before the Academy a remarkable piece of apparatus called a magnetarium, now deposited at the Conservatory of Arts and Crafts. With this instrument it is possible to reproduce on the surface of a sphere with surprising accuracy a distribution of magnetism like that on the earth, imitating also its periodic variations. The committee on prizes thought it would be fitting to make the first award from the prize fund endowed by Mr. Henry Wilde for research work on the question of terrestrial magnetism. Since 1869 the annual reports of the United States Coast and Geodetic Survey have published every year notes of considerable interest from the pen of Dr. Charles A. Schott on the determination of the strength of the earth's field at the permanent observatories of the United States, and at many temporary stations as well. The extensive labors of Mr. Schott do not admit of being abstracted easily. His notes embrace an exposition of the methods used at observatories, and on his expeditions; a review of the work that has been done in this line of investigation from the time that it was first begun on the American continent, and also to a certain extent the work at foreign stations; a well thought-out discussion of the records taken from the variation-recording instruments at certain of the observatories, together with a study of the daily and the monthly variations and the influence of the moon. Finally, a large number of personal observations made at various isolated stations, showing the trend of the magnetic field over the North American continent. The sum total of these labors constitutes one of the most important contributions to the history of terrestrial magnetism, and the committee was unanimous in its award of the Henry Wilde prize to Dr. Schott. The Gegner prize was awarded to Madame Curie for her contributions to science. This lady has published a lengthy investigation of the magnetic properties of the various brands of iron and steel of commerce. She studies with great exactness, following the best experimental methods, the influence of hardening and annealing and the qualitative and quantitative effect of admixtures of other metals, such as tungsten and molybaden, on the magnetic receptivity, and the residual magnetism of iron and steel. This work is of great import to manufacturers of permanent magnets and of dynamo-electric machinery. Madame Curie has also studied the question of the emission of the so-called uranium rays in many bodies, and has discovered that the alloys of thorium behave, in this respect, much like those of uranium. At one of the recent meetings of the Academy, M. Becquerel read a communication from M. and Madame Curie on these rays. The results of their work seem to show that the properties of pechblende (uranium oxide) are the result of a new substance which the authors have called polonium. The Houllevigne prize was awarded to Mr. Edward Branly. The scientific investigations and the many unexpected results of his exact and ingenious experimentation have long made him prominent among physicists. To him are due the demonstration of the identity, throughout the spectrum, of the coloring matter of the blood of vertebrates; the discovery that electrified bodies may be discharged by the impact of the ultra-violet rays; the discovery of considerable variation in contact-resistance between metal discs, according to the nature of the metals employed. Mr. Branly's investigations on the conductivity of metallic filings have been particularly prominent. The application of his results to the receiver, which has made Hertzian telegraphy possible, has prepared for the author a niche in the history of electricity of which no one can despoil him. This happy invention would alone merit the highest recognition at the hands of the Academy. The Kastner-Boursault prize was established to be awarded to the best work treating of the various applications of electricity to the arts or in commercial life. Two works were considered for this prize, one by MM. André Blondel and F. Paul Dubois, both government engineers; the other by M. Paul Janet, a professor at the École Supérieure d'Electricité. MM. Blondel and Dubois' work is entitled "Electric Traction on Railways." There are to be three volumes, two of which are already out. The authors, one of whom, by the way, has already been honored by the Academy, traveled much in Europe and America, and collected a mass of information, from which they have been able to make a very comprehensive statement of the existing condition of electric traction. This portion of the work would be sufficient to attract the notice of the Academy. But the reader is struck at once by the thorough exposition made in certain chapters of the various phases of the traction problem. Some of these, in fact, like the chapter on acceleration, are complete treatises, and give the work originality and breadth of scope. The authors have attempted to deduce from the lessons and results of experience general principles which may serve as reliable guides to the study of future improvement and advance. The committee considered the worth of this work so great as to entitle it to receive a prize. But they could not overlook the strong claims of the other work to a place in the advancement of the arts. The course in the commercial applications of electricity conducted by M. Paul Janet, reduced to print in his book, has acquired a reputation which is borne out by the size and quality of the audiences which it draws every year. The committee, knowing that M. Janet is the author of several excellent treatises, and approving as it does the tenor and method of his teaching of applied electricity, to which he has devoted his life, and recognizing the importance of this work to the advancement of industry, considered that he ought to be awarded a prize of equal value with that awarded to his competitors. Accordingly the committee divided the prize equally between MM. André, Blondel and F. Paul Dubois, on the one hand, and M. Paul Janet on the other.

General News.

New Incorporations.

THE MONTGOMERY TELEPHONE COMPANY, Montgomery, Mo., has been formed with a capital of $3,000. The incorporatorsr are A. B. Chance, A. E. Kemper, J. W. Jacks and H. S. Jacks.

THE VAN NORT BROTHERS ELECTRIC COMPANY, St. Louis, Mo., has been incorporated with a capital stock of $5,000. Among those interested are S. P. Van Nort, S. Van Nort and J. B. Woods.

THE ECONOMIC LIGHT & POWER COMPANY, Newark, N. J., has been incorporated with a capital stock of $100,000. The incorporators are Horace M. Decker, Richmond C. Coventry and Frederic M. Payne.

THE CITIZEN'S HEAT, LIGHT & POWER COMPANY, Waterloo, Iowa, has been formed with a capital stock of $100,000, by G. W. Dawson, J. D. Easton, G. E. Lichty, J. E. Sedgwick, C. W. Mullan, W. W. Miller, C. E. Pickett, F. C. Platt.

THE MIDDLESEX ELECTRIC COMPANY, Newark, N. J., has been incorporated with a capital stock of $100,000. The incorporators are Manning Freeman, John M. Connor, Herbert C. Richardson, Metuchen; Willard S. Muchmore, Frederick G. Agens, Jr.

THE ELECTRIC BOAT COMPANY has filed articles of incorporation with the Secretary of State at Trenton, N. J., with an authorized capital stock of $10,000,000. The incorporators are Charles Blizard, William H. Palmer and Augustus C. Treadwell, Jersey City, N. J.

THE MARYLAND TELEPHONE COMPANY, Baltimore, Md., has been incorporated with a capital stock of $1,250,000. The incorporators are Henry A. Parr, George R. Webb, Pinkney W. Wilkinson, Thomas F. McGlone and John Waters. Further information regarding this enterprise is given in the Telephone Notes in this issue.

THE TACOMA RAILWAY & POWER COMPANY has filed articles of incorporation with the Secretary of State with a capital stock of $2,000,000. The incorporators are Gordon Abbott, Charles E. Cutting, C. H. Coster, T. Jefferson Coolidge, Jr., Samuel Carr, S. Endicott Peabody and Bird S. Coler. The company will furnish electricity from water power to the street railroads and factories of Tacoma.

THE CREHORE-SQUIER COMPANY has been incorporated in Cleveland, Ohio, with a capital stock of $1,000,000, for the purpose of conducting a telegraph business. The company proposes to use the synchronograph, which is the invention of Messrs. Crehore and Squier, an account of the test of which system on the telegraph lines of the British Government was published in The Electrical World of January 29, 1898.

THE MASSENA ELECTRIC STREET RAILWAY COMPANY has been incorporated at Albany, N. Y., with a capital stock of $100,000, to operate a street surface electric road from the Massena Springs Station to the St. Lawrence River, at a point where the canal of the St. Lawrence Power Company intersects the river. The entire length of the road and its branches is to be 67 miles. The directors are Thomas S. Gillespie, Robert Johnston, Edward M. Stothers, Howard Hasbrouck, Edward J. Dolan, Thomas D. Harris, Willard S. Esselstyn and James H. Jones, of New York, and Robert Swan, of Massena.

The Telegraph and Telephone.

BENTON HARBOR, MICH.—The Twin City Telephone Company has increased its capital stock from $25,000 to $50,000.

ASHTABULA, OHIO.—The Ashtabula Telephone Company has increased its capital stock from $15,000 to $30,000. It now has 400 telephones connected.

GRAND RAPIDS, MICH.—Two Michigan local telephone companies—the Northern Telephone Company and the Emmett County Company—have been combined.

MIDDLETOWN, PA.—The Pennsylvania Telephone Company has completed its lines from Hummelstown, Dauphin County, to Mount Holly, Cumberland County.

CHICAGO, ILL.—The Chicago Telephone Company is asking the city for an extension of its franchise, and agrees to pay $50,000 a year to the city, or 3 per cent. on its gross income.

MARQUETTE, MICH.—The Postal Telegraph Company is erecting a second wire between Chicago and Marquette. This will give the company two direct lines between the two points.

BATAVIA, N. Y.—A new telephone company has been incorporated to operate a system in Cattaragus County. The name of the company is the Little Valley Telephone Company, and its capital stock is $500.

QUINCY, ILL.—The Champaign-Urbana Telephone Company, which was incorporated in 1895, with a capital stock of $40,000, has been placed in the hands of a receiver. This action was precipitated by a judgment against the company for $800 secured by the Citizens' Banking Company, of Champaign.

PITTSBURG, PA.—The local telephone companies of Braddock and Homestead are considering an arrangement which will give them service in both towns by connecting the two systems. The Bell Company is fighting this enterprise in both places and has reduced its rates to those charged by the local companies. This represents a cut of about 75 per cent. for unlimited service, but less for the limited service.

PITTSBURG, PA.—Prominent business men of Wilkinsburg have under consideration a plan for the forming of a telephone system in that town. The promoters propose to install a system to be operated on a moderate rate of charges, and connect it with Braddock, Homestead and McKeesport, and eventually with Pittsburg. Mr. H. W. Cleland, an electrical contractor, is at the head of the enterprise.

SYRACUSE, N. Y.—A bill has been introduced in the Legislature to regulate telephone charges in this city as follows: For each telephone located within a radius of one half-mile from the central office, $36 per annum; out-

side of such radius an additional charge not to exceed $4 per annum. Each residential telephone within the same radius, $30 per annum; outside, an additional charge not exceeding $3 per annum.

WASHINGTON, D. C.—A bill to incorporate the Columbia Telephone Company was recently referred to the Commissioners of the District of Columbia. The commission has reported adversely on the bill on the ground that the telephone service can be better rendered by a single company under proper management, and at proper rates, than by two or more companies having separate lines and instruments.

LANCASTER, PA.—Merchants of this city are circulating for signatures a paper addressed to the Bell Telephone Company in this city to the effect that they will refuse to sign any contract with the company for the next quarter or for any specific time unless the company agrees to abandon the toll rates, and to make the rates from the date of signing contracts $24. They also demand a contract for the term of five years, with the privilege of five years' extension.

BALTIMORE, MD.—The Maryland Telephone Company, which was incorporated on February 6, proposes to ask the city council for a franchise to establish a new system in this city. It is stated that the persons interested in this movement are identified with like interests in other cities where independent exchanges are being established or are proposed. It is the purpose of the promoters to provide money to establish a complete plant for 6000 telephones that will cover all parts of the city and reach out into the suburban districts.

CINCINNATI, OHIO.—At the regular weekly meeting of the "Optimist Club," of this city, on February 4, a novel feature was introduced at the banquet. Fifty telephone receivers were placed at the fifty plates arranged for the diners. After the dinner Mr. S. M. Felten, president of the club, who was at the time in Chicago, called the members to order by telephone, each of the members holding his receiver to his ear to catch the words of the distant chairman. President Felten conducted the business of the meeting by wire. He called on the clerk to read the minutes of the last meeting, and then introduced Captain Stone at the Chicago end. Captain Stone made a few remarks on "Switchboards." He briefly outlined the development of the telephone switchboard, tracing the improvements step by step down to the modern board in which the subscriber's drop is substituted by incandescent lamps. The arrangement of the post-prandial entertainment was novel, and was a brilliant success.

ELECTRIC LIGHT AND POWER.

COXVILLE, IND.—The Brazil Block Coal Company has recently purchased for its electric mining plant a 150-hp engine built by the Ball Engine Company, of Erie, Pa.

MIDDLETOWN, CONN.—A petition is being circulated in this place requesting the City Council to establish and maintain at public expense a city electric light and gas plant.

PORT JERVIS, N. Y.—The Port Jervis Light & Power Company will erect a new power house adjacent to the present plant. The plans call for three new generators of a capacity of 260, 200 and 100 horse-power respectively, at a cost of $29,000.

KANSAS CITY, MO.—The Baltimore Hotel, of this city, has ordered a direct-connected outfit consisting of one 75-kw and one 60-kw General Electric generator, each direct-connected to engines built by the Ball Engine Company, of Erie, Pa.

CHARLOTTE, N. C.—It is stated that a syndicate of New York and Philadelphia capitalists have bought the "Narrows" of the Yadkin River, near here, and will develop the power and transmit it electrically to Salisbury, Concord and probably to Charlotte and other surrounding towns for light and power purposes. The deal involves $5,000,000, and is said to be the largest transaction that has ever taken place in the State. Cotton mills and other industries, it is stated, will be built on adjoining property.

HOBOKEN, N. J.—The North River Light, Heat & Power Company has been organized in this city, with a capital stock of $300,000, all of which has been subscribed by Hoboken citizens. The plant will be erected on the site just east of the power house of the North Hudson Light, Heat & Power Company, on Fifteenth Street, in this city. It is stated that the new company is making contracts to furnish light at rates 25 per cent. lower than those asked by the old company. Mr. A. K. Bonta is at the head of the enterprise, and is one of its incorporators. The names of the other two incorporators are Arthur Seitz and W. C. Anderson.

THE ELECTRIC RAILWAY.

GREENFIELD, IND.—Messrs. Francis G. Banker and William C. Dudding have petitioned for the right to maintain and operate a street railroad in this city for a period of thirty years.

BALTIMORE, MD.—During the recent cold spell the Consolidated Railway Company, of this city, each morning and evening served hot coffee to its motormen and conductors at the termini of its lines.

AKRON, OHIO.—The Akron, Bedford and Cleveland Electric Railway is surveying a line from a point above Cuyahoga Falls to Hudson, a distance of 8 miles, with the intention of constructing a branch road.

WASHINGTON, D. C.—The Brightwood Avenue Railway has passed into the hands of those holding the controlling interest in the recently consolidated lines, to be known as the Washington City Railway, and it will henceforth be operated as a part of that system.

FAIRHAVEN, MASS.—There is a movement on foot in this town favoring the establishment of a municipal electric light plant. A committee to investigate and report will probably be chosen at the town meeting in March. Mr. Norman M. Paull is interested in the enterprise.

DETROIT, MICH.—A consolidated mortgage for $1,000,000 has been given by the Detroit, Ypsilanti & Ann Arbor Electric Railway Company for the purpose of taking up $600,000 of bonds, which will mature in 1907, the balance, $400,000, to be used for extensions and improvements.

UTICA, N. Y.—The Frankfort & Utica Street Railway Company has arranged to extend its road to connect with the Little Falls & Herkimer Street Railway so as to form a continuous line from Utica to Little Falls. The work on the extension will be commenced early in the spring.

BOSTON, MASS.—The scholarly attainments of the editor of the Boston "Globe" have been offended because a street car conductor in that city calls out "Union dappo!" as his car approaches that locality. The editor suggests that the railway company start a night school for its conductors.

STREATOR, ILL.—A franchise has been granted by the City Council to Cary C. Barr to build and operate a street car line in this city. The franchise covers a period of 35 years, and the lines will connect with the interurban road to be constructed between this city, Ottawa and LaSalle.

HAMILTON, OHIO.—The Dayton & Western Traction Company, whose lines run from this city to Eaton, has passed into the hands of a Dayton syndicate. The road is stocked and bonded for $200,000. All of the members of the syndicate are stockholders in the City Railway Company of Dayton.

MINNEAPOLIS, MINN.—It is stated that the Hopkins Electric Railway will be extended to Excelsior. It is proposed to run cars to Lake Minnetonka over the tracks of the Great Northern Railroad Company on the Hutchinson branch. It is stated that the steam locomotives will be abandoned on this branch.

SOUTH BEND, IND.—Contracts are being awarded for the building of an electric railway between South Bend, Ind., and Niles, Mich. It is stated that the capitalists controlling the South Bend and Elkhart lines are favorable to the building of an electric line to Sturgis connecting with the projected Indiana-Michigan roads.

GARRETTSVILLE, OHIO.—A committee of representative citizens has been named to confer with the officials of the Chagrin Falls & Eastern Electric Railroad to secure an extension of the line through this place. It is thought that this route will be preferable to the northern route, which is under consideration by the railroad company.

LEXINGTON, MASS.—The authorities of Lexington have granted a franchise to the Lexington & Boston Street Railway Company. It is understood that the company intends to extend its lines from Arlington Heights to Billerica, where connection can be made with the electric road for Lowell, thus completing a new line from Boston to Lowell.

HARTFORD, CONN.—The Hartford & West Hartford Horse Railway Company, known as the "Suburban," has passed into the control of State Treasurer Mersick, who will manage the property in the interests of the first mortgage bondholders. Treasurer Mersick has appointed Mr. James T. Patterson, of Bridgeport, to act as the agent of the road, and Mr. Patterson has taken charge of the property.

HARTFORD, CONN.—A bill has been prepared for introduction in the Legislature requiring the street railway companies to reduce the fare for school children on local and suburban trolley lines. The reason given for the drawing up of the bill is that the children of poor parents are compelled to walk long distances to school because they cannot afford to pay the present rates of fare, while if the fare were reduced to 2½ cents they would probably all ride, and therefore be better able to attend to their school duties.

GLENS FALLS, N. Y.—Mr. L. L. Ashley, president of the Kane's Falls Electric Company, has secured title to several pieces of land on both sides of the Hudson River between the feeder dam and Palmer's Falls, with the view of developing the water power which is available between those two points. The Kane's Falls company has a franchise in Glens Falls and contracts to light the villages of Whitehall and Fort Ann, and the development of this water power will be of great value. The fall in the river from Palmer's Falls to the proposed side of the upper dam is 75 feet, with a similar fall from that point to the proposed location of the lower dam. Mr. Ashley's plans contemplate the building of a stone dam 75 feet high and about 800 feet wide.

ALBANY, N. Y.—The State Board of Railroad Commissioners on February 8 approved the applications of the Metropolitan Street Railway Company and the Broadway and Seventh Avenue Railroad Company, of New York, for a change of motive power to the open-conduit system, on the following-named streets and avenues in Manhattan Borough: From the intersection of Lexington Avenue and Ninety-sixth Street, along Ninety-sixth Street to First Avenue, to Ninety-third Street, thence to a point near the entrance to the Astoria Ferry; also from Third to Fourth Streets, between West Broadway and West Street. The application of the New York and Harlem Railroad Company and the Metropolitan Street Railway Company, its lessee, for change of motive power to the open-conduit system on certain portions of the New York & Harlem Railroad was also granted.

LEGAL NOTES.

THE USE OF HOTEL TELEPHONES.—On February 4 the injunction which was recently granted to the Chesapeake & Potomac Telephone Company in Washington against the general use of the telephone by the guests of a Washington hotel, has been made permanent. The judge ordered that the telephone must be used only for legitimate business of the hotel and for the private business of the manager. It might also be used for the convenience or accommodation of guests in sending for a wagon to call for their baggage, but not for other purposes, such as calling for stock reports, ordering theatre tickets, making social or business engagements, etc. In the course of the opinion Judge Cox said that the hotel guest does not have a telegram sent free of charge, nor does he receive messenger service free, or the use of carriages without pay; why should he, then, expect to have the use and service of the telephone without pay?

THE NASSAU ELECTRIC RAILROAD COMPANY gave a note for $20,000 to the Thomson-Houston Electric Company in settlement of a suit brought against it in the United States Circuit Court, New York, for the infringement of certain patents owned by the latter company. On this note

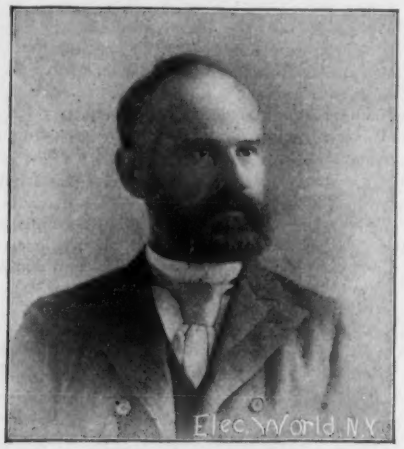
$2,500 had been paid, and then a suit was brought in the Supreme Court in Brooklyn by the General Electric Company to recover the balance of $17,500 due upon the note of the Nassau Company. A year later the patents of the Thomson-Houston Electric Company were declared void in the suit against the Hoosick Railway Company, the patents involved in this case being the same as those which formed the basis of the Nassau suit. The Nassau Company then set up that judgment as a defense in the action against it, the want of a valid patent and failure of consideration for the note. A counter claim was also interposed for the $2500 paid. The Second Appellate Division has affirmed judgment entered upon the report of the referee in favor of the plaintiff.

Personal Note.

MR. WILLIAM E. BAKER has been appointed general superintendent and chief electrical engineer of the Manhattan Elevated Railway Company, of New York. Mr. Baker, who is forty-two years of age, is a native of Springfield, Mass., and was graduated from Lafayette College in 1877. He afterward became connected with the engineering staff of the St. Paul & Pacific Railway, and later with the St. Paul, Minneapolis & Manitoba, the Canadian Pacific and the Great Northern Railway Companies. In 1888 he came East, and was employed by the Thomson-Houston Electric Company to install the electrical equipment of the West End Street Railway Company, Boston. He had charge of the construction of the Intramural Railway at the World's Fair, in Chicago, and afterward became general superintendent of the Metropolitan West Side Elevated road in that city, which position he held up to the time of his present appointment.

Obituary Note.

MR. JESSE H. BUNNELL, head of the firm of J. H. Bunnell & Co., electrical supply dealers, New York City, died at the Hotel St. George, in Brooklyn, on the evening of February 8, from weakness following an attack of the grip. Mr. Bunnell was born in Ohio in 1843, and became a telegraph operator in early life. He was engaged in the military telegraph service during the Civil War, and was an active participant in some of the most stirring events of those memorable times. He was attached to the Army of the Potomac and the Army of the Cumberland, serving at the headquarters of Generals McClellan, Burnside, Rosecrans, Thomas and Sherman as their personal telegrapher. At the battle of Antietam he established an office on the field, and sent and



The Late Jesse H. Bunnell.

received messages under fire. After the war he returned to New York, and in 1872 he became a partner in the firm of Partrick, Bunnell & Co., of Philadelphia, manufacturers of telegraph and electrical supplies. From 1875 to 1878 he was connected with the firm of L. G. Tillotson & Co., of New York. In the latter year he started the business bearing his name, with which he was continuously identified until the time of his death. The remains of the deceased were buried in Greenwood Cemetery. The pall bearers represented the commercial and railroad telegraphers, United States Military Telegraph Corps, the electrical press and the electrical trades. They were: Mr. A. B. Chandler, president of the Postal Telegraph Company; Mr. F. W. Jones, electrical engineer of the same company; Mr. Charles A. Tinker and James Merrihew, both general superintendents of the Western Union Telegraph Company; Colonel James Gilmore and W. J. Dealy, of the U. S. Military Telegraph Corps; Mr. Robert Stewart, superintendent of telegraphs of the Central Railroad of New Jersey; C. W. Price, editor of the "Electrical Review," and Mr. Charles McLaughlin, surviving member of the firm of J. H. Bunnell & Co. The greater part of these were also members of the Old Time Telegraphers' Association. Mr. Bunnell leaves a wife, two sons and two daughters.

Trade and Industrial Notes.

MESSRS. GOULD & EBERHARDT, Newark, N. J., have sold the Eberhardt patent tool holder and all connected therewith to the Hugh Hill Tool Company, Anderson, Ind.

THE B. F. STURTEVANT COMPANY, Boston, Mass., has issued the second edition of Bulletin G, describing and illustrating the Sturtevant generating sets with automatic horizontal and upright engines.

THE KESTER ELECTRIC MANUFACTURING COMPANY, Buffalo, N. Y., will, on March 1 next, move its manufacturing plant to Chicago, Ill. The new factory will be located at 241 South Jefferson Street, Chicago.

DUNCAN & EYRE.—Dr. Louis Duncan and Mr. Manning K. Eyre have entered into a partnership as consulting engineers under the above firm name, with offices in Rooms 1514 and 1515 Empire Building, 71 Broadway, New York. The partnership dates from January 14 last.

THE LEATHER PRESERVER MANUFACTURING CORPORATION, 27 West Monroe Street, Chicago, has recently successfully cleaned two very large belts, one, 54-inch, three-ply, weighing 2000 pounds, for the city of Chicago, and the other, 36-inch, three-ply, weighing 1800 pounds, for the Illinois Steel Company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is publishing a map of Chicago's business district on which is shown the company's new location at 92 and 94 West Van Buren street. Cable cars may be boarded anywhere on the "loop"; they all run past the company's door, and pass within convenient distance of the hotels.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, St. Louis, Mo., has moved its office and factory to 909 Market street. The company now occupies the three-story building at that number, which has a floor area of 8,500 square feet. This space is entirely utilized by the company in the manufacture of telephone apparatus and electrical specialties.

PROF. JOSEPH W. TROTTER, 160 Eckford Street, Brooklyn Borough, New York City, announces that he will manufacture and place upon the market a commutator compound which can be used with safety on gauze and carbon brushes. It will, it is stated, avoid the necessity of using sand-paper or any other material that is liable to injure the surface of the commutator.

LUDEWIG-THURBER MANUFACTURING COMPANY, LTD.—The Electrical World is indebted to this firm of electrical engineers, whose headquarters are at 565 Old Avenue, Pittsburg, Pa., for a copy of a work giving 100 views of Pittsburg. The contents consist of half-tone illustrations of the principal business buildings, residences and general views of various industrial establishments and localities of note in and about the city.

THE TECHNOLOGY REVIEW is the title of a new quarterly magazine relating to the Massachusetts Institute of Technology. It is published in Boston by the Association of Class Secretaries, and the January number, which is the first one, contains much information of particular interest to the alumni of this institution. The frontispiece contains a photographic print of President Crafts. The magazine is gotten up in a very attractive form.

THE EUREKA ELECTRIC COMPANY, Chicago, Ill., has placed upon the market a magneto bell which it claims to be a superior instrument. The contacts throughout are platinum; the bell is full nickeled; the ringer is of the W. E. style and the generator is highly finished. The company's new No. 44 transmitter is meeting with a ready sale, and, it is stated, is giving excellent satisfaction. The transmitter is claimed to be constructed on scientifific principles, and is built to last and give good service.

THE JENNEY ELECTRIC MANUFACTURING COMPANY, Indianapolis, Ind., has authorized an increase in its capital stock from $50,000 to $80,000. The company reports that its trade is growing so rapidly that it was thought best to prepare for an extraordinary business during 1899. The "Jenney" dynamos and motors enjoy such a good reputation that the agents report it an easy matter to sell them. The company has territory to dispose of to agents, and it advises those who desire to take agencies to make application therefor.

THE SOMMER ELECTRICAL COMPANY, Newark, N. J., has opened its headquarters at 785 Broad Street, where it will conduct a general electrical contracting business, according to modern methods and with progressive ideas. The company's business will include installing electric isolated plants complete, watchmen's clocks, gas lighting, intercommunicating telephones, dynamos, motors, burglar alarms, etc., etc. It will also engage in electric light wiring, and will make a feature of decorative illumination for special occasions. Mr. Alfred Sommer is the manager.

THE AMERICAN VITRIFIED CONDUIT COMPANY, of New York, has been awarded the entire electrical conduit contract for the city of Baltimore, which calls for several million feet of multiple-duct vitrified conduit. The ducts vary in number from two to sixteen. The Vitrified Conduit Company has various contracts on hand at the present time, including one for 1,000,000 feet of duct for the Narragansett Electric Light Company, Providence, R. I.; also one for the Edison Electric Illuminating Company, and another for the Western Union Telegraph Company, at New Orleans, La.

A GENERATOR OF INTERRUPTED CURRENT.—In the description in these columns, page 156, February 4, 1899, of a new machine brought out by the Triumph Electric Company, Cincinnati, Ohio, it was stated that "the machine generates a rectified or pulsatory alternating current * * * * * " Through a misarrangement of the words this gives the wrong impression, as the machine really generates a rectified alternating or pulsatory current, the external current being a direct current, that is, non-alternating in character, but pulsatory in that the impressed electro-motive force has a half-sinusoidal wave form.

THE PITTSBURG BOILER SCALE RESOLVENT COMPANY, Pittsburg, Pa., manufactures a boiler scale resolvent which is evidently giving satisfaction judging from the large number of testimonials printed in a pamphlet issued by the company. The Pittsburg resolvent has for its base a rich natural oil deprived of all substances that would in any degree prove injurious if admitted into the boiler. This oil is compounded with other elements which aid its resolving action on scale already formed and which prevents any tendency toward foaming. Its action is mechanical and not chemical, and consists in coating the inside of the boiler lightly, yet sufficiently to prevent any scale from attaching itself to the iron.

MESSRS. J. HOLT GATES & CO., Marquette Building, Chicago, Ill., have made a large number of sales recently, among which may be noted the following: Five slow-speed motors ranging from 15 to 150 horsepower for Armour & Company's stock yards, Chicago; also one 200-hp motor and one 10-hp motor for the same concern; Mason City & Clear Lake Railroad, Mason City, Iowa, two 15-hp motors; The Elkhart Lake Light & Power Company, Elkhart Lake, Wis., five transformers; The Alley Elevated Railroad, Chicago, thirty-six 600-ampere switches; Cosmopolitan Construction Company, Chicago, transformers of 600 lights' capacity; Hartwell Lumber Company, Chicago, one $700 switchboard; Mandell Brothers, Chicago, one 3-hp motor and one 5-hp fan outfit; P. E. Elevier, West Superior, Wis., two 100-light dynamos.

MR. JAMES G. BIDDLE, Drexel Building, Philadelphia, has just received a large order from the United States Government covering a set of fine electrical testing instruments for measuring insulation, capacity and resistance of cables. This outfit will be placed on the United States cable-ship "Panama," which is about to sail from New York for the Philippine Islands. The above indicates that the cable-testing apparatus handled by Mr. Biddle, and for which he reports having had large demand during the past year, is right up to date. Engineers and others interested in such matters will probably find it advisable to communicate with Mr. Biddle. The demand for "Jagabi" portable testing sets is also increasing. This instrument is handled exclusively by Mr. Biddle, who makes a specialty of high-class instruments. He has recently received a number of testimonial letters from users of "Jagabi" sets. The instrument is highly spoken of in each instance.

A NEW ENGINE MOTION.—The Parsons Engine Company, Wilmington, Del., has issued a neat little pamphlet describing the Parsons engine motion, which is attracting some attention among engineers. The principle embodied in this engine motion is one well known to the machine shop because of its frequent use in the quick return movement of shapers, etc., but, it is stated, has never been before directly applied to engine use. The claims made for this motion are that it admits of reversing, compounding and duplexing with ease; it gives an engine without a movable valve when a fixed cutoff is required; a rotary engine wherein a hand or automatic cutoff is a feasible part of the design; a change of cutoff from zero to unity without varying the point of release, compression or admission in the slightest degree, and a link motion that increases the leverage on the fly wheel shaft as the pressure drops due to expansion after cutoff, thus giving, it is claimed, a more uniform pull than is found in the reciprocating engine. It is said to be much cheaper of construction for a corresponding power than is possible in the present types of engines.

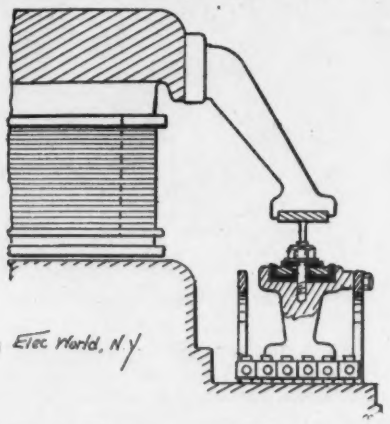
MECHANICAL DRAFT.—The B. F. Sturtevant Company, Boston, Mass., states that many boilers on land and sea have been equipped with mechanical draft. In THE ELECTRICAL WORLD of July 16, 1898, reference was made to the removal of the chimney at the Sturtevant Company's works and the substitution therefor of mechanical draft. By this system a chimney is only needed to carry the gases high enough to conveniently discharge them into the atmosphere. According to the conditions a fan may be applied at from 20 to 40 per cent. of the cost of the chimney, and where the chimney draft is not sufficient the fan may for very little cost be added to help it out. A blower can be arranged so as to force the air under the fires and cause it to pass up through them, and thus give perfect combustion, or on shipboard it may be so arranged in connection with the boilers that the air may be heated by the gases as they escape, thereby saving coal. This possible saving of heat is one of the most important advantages of mechanical draft. With the chimney 20 to 30 per cent. has to be wasted in the hot gases in order to produce the draft. The fan requires only about 1-75 as much power to move the same amount of air and therefore makes it possible to save as much of the remaining heat as is practicable. The fan can be built of any size and exactly adapted to any locations and regulated to suit the requirements. Bulletin E, published by the Sturtevant Company, gives information on the subject of mechanical draft, and a copy of it may be had on application.

THE ELECTRICAL INSTALLATION AT THE INDIAN HEAD PROVING GROUNDS.—This installation, which was briefly referred to in THE ELECTRICAL WORLD of February 4 last, will comprise two 500-hp and one 125-hp engines, making a total of 1125 horse-power. The electrical portion of the contract includes the following apparatus: Two 250-kw alternating and direct-current engine-type generators, and one 75-kw alternating-current engine-type generator; eleven polyphase induction motors, ranging in size from 5 to 30 horse-power; two 100-hp electrical locomotives, and one combined passenger and freight car equipped with two 25-hp, 500-volt, direct-current railway motors; an electric railway system, part of which will be operated by overhead trolley and part by the surface-contact system, together with transformers, exciters, switchboards, lightning arresters and all the other necessary auxiliary devices. The contract for the engines was awarded to Westinghouse, Church, Kerr & Co., who will supply engines manufactured by the Westinghouse Machine Company. Each of the dynamos in the generating station is to be driven by its own engine. From the direct-current ends of the alternating and direct-current generators current will be supplied at 550 volts to the electric railway. From the alternating-current ends of these machines, or from the 75-kw alternating-current generator, will be supplied the two-phase current for the operation of the induction motors in the powder mills; also current for lighting the powder mills, offices, dwellings and workingmen's houses adjacent to the proving grounds. It is intended that the alternating and direct-current generators shall run in multiple with each other at either the alternating or direct-current terminals, or that either of them shall run in multiple with the 75-kw generator when necessary. The latter may, therefore, be used as auxiliary to either of the 250-kw generators in supplying power to the powder mills, or may be used alone for light loads in supplying either light or power, or both. The system therefore provides great flexibility in its application. The contract for the entire electrical equipment was awarded by the United States War Department to the Westinghouse Electrical & Manufacturing Company. The Government has facilities at Indian Head for testing guns, armor-plate and explosives. Indian Head is on the Potomac River, about 28 or 30 miles below Washington.

UNITED STATES PATENTS, ISSUED FEBRUARY 7, 1899.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

618,837. CONDUIT FOR WIRES OR CABLES; E. H. Callaway, of New York, N. Y. App. filed Dec. 24, 1897. In a conduit for electric wires or cables, the combination of sections made of suitable material, and provided with longitudinal perforations, inner sections of tubes of insulating material smaller in diameter than the perforations and means for supporting the inner tubes in a central position in the perforations so as to form a film or wall of air between the tubes and the walls of the perforations.



No. 618,853.—BRUSH-HOLDER FOR DYNAMO-ELECTRIC MACHINES.

618,848. ELECTRIC-ARC LAMP; W. E. Dennis, of New York, N. Y. App. filed Jan. 22, 1898. In a mechanism for operating the electrodes of an electrical arc-lamp the combination with the operating-magnets, helices, and armature, of the tube enclosing the carrier, the continuous rack-bar secured to the armature, or removable core, and arranged to move with the same, and to clutch the carrier and to release it by the movement of are armature or core, controlled by the electric current in its passage from one electrode to the other, all constructed to operate substantially as described.

618,853. BRUSH-HOLDER FOR DYNAMO-ELECTRIC MACHINES; G. S. Dunn, of East Orange, N. J. App. filed April 30, 1898. In a dynamo-electric machine, the combination of a commutator, a brush-holder rigging centered upon the axis of the commutator and revolvable in a circle concentric thereto, and brush-holder supports mounted upon the rigging and independently adjustable thereon circumferentially around the commutator, and adjustable together around the commutator by the movement of the rigging, substantially as described.

618,864. APPARATUS FOR OPERATING ELECTRIC BRAKES; H. S. Graber, of St. Louis, Mo. App. filed July 25, 1898. The combination of a storage battery, an electric motor, an electric circuit in which they are arranged in series, an electro-magnet, a rheostat and a sound electric circuit in which said battery magnet and rheostat are arranged, and through which no electricity from the first circuit flows.

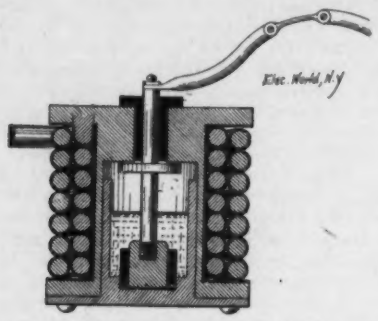
618,876. CIRCUIT BREAKER AND CLOSER; A. T. Hill, of Detroit, Mich. App. filed June 8, 1897. The combination with a track-circuit and a signal-circuit normally open, of an electromagnet arranged in the track-circuit, a circuit-closing device for the signal-circuit controlled by the magnet, means for automatically locking the closing device in said signal-circuit, an independent motor for releasing the closing device, and a combined brake and impelling device for stopping and starting the motor.

618,911. TROLLEY CONNECTION FOR CANAL-BOATS; F. J. Shewring, of Toronto, Canada. App. filed Feb. 7, 1898. In a trolley system for canal-boats, a trolley consisting of a frame embracing in its construction two vertical members, each member composed of two opposite sides united at their upper ends, a depending arm from each vertical member at one side thereof, bent horizontally below the wheel and then perpendicularly, a counterbalance connected to the lower ends of the depending arms, a rod connected to the arms above the counterbalance, and a sliding ring mounted on the rod to which is adapted to be attached the connection for the trolley-pole.

618,920. ELECTRIC HAND-LIGHTING GAS-BURNER; H C. Thomson, of Boston, Mass. App. filed May 31, 1898. In an electric hand-lighting gas-burner, in combination with the ordinary burner-pillar, a fixed electrode consisting of a coiled spring, properly attached to the burner-pillar and terminating in an electrode-point, and a pin with the said coiled spring; a ratchet-wheel loosely journaled upon the gas cock stem and supporting said electrode-pin; a plate-piece rigidly fixed to the gas-cock stem, having its upper arm adapted as a movable electrode and having teeth upon its lower plate edge; a spring-clutch rigidly attached to said plate-arm to move said ratchet-wheel; a thumb piece or key carrying a plate having teeth adapted to gear with the teeth upon the bottom of the plate-piece, substantially as described.

618,935. ROTATING ELECTRIC MOTOR. W. P. Freeman, of New York, N. Y. App. filed Feb. 25, 1898. In combination with a suitable standard an electric motor turning on ball-bearings upon the said standard and sliding electrical connections between the terminals of the said motor and conductors secured to the said standard, the said connections being inside of the said bearings.

618,950. LIGHTNING-ARRESTER; E. C. Parham, of Johnstown, Pa. App. filed June 26, 1897. The combination, in a lightning-arrester, of two pairs of normally-separated electrodes, and means for simultaneously increasing the gap between one of said pairs and closing the gap between the other of said pairs, when current is flowing through the device.



No. 618,950 —Lightning Arrester.

618,954. RESISTANCE PANEL OR GRID; A. C. Dinkey, of Munhall, Pa. App. filed June 20, 1898. A resistance-frame having a movable support over which the winding extends and means for adjusting this support to pull the winding taut, substantially as described.

618,992. CLEANER FOR COMMUTATORS; J. T. Morrow, of Great Falls, Montana. App. filed Sept. 29, 1898. A cleaning device for commutators combining a winding-on drum or reel for the cleaning fabric or material and power-driven connections for turning such drum or reel, substantially as described.

618,993. ELECTRICAL BATTERY; L. Paget, of New York, N. Y. App. filed July 8, 1897. A battery having a metallic retaining vessel, in combination with a metallic electrode which fits snugly within said vessel, said electrode and the inner surface of the vessel being amalgamated, substantially as described.

619,014. ELECTRIC-ARC LAMP; T. E. Drohan, of Chicago, Ill. App. filed Dec. 1, 1898. The combination with a carbon-holder of an arc-lamp, of a mounting therefor permitting the same to be moved away from its normal position to permit the lamp to be trimmed; switching mechanism controlling the continuity of the lamp-circuit, and a connection between said carbon-holder and switching mechanism, whereby the latter is automatically actuated by the movement of said carbon-holder, substantially as described.

619,023. TORPEDO-CONTROLLING DEVICE; W. D. Litchfield, of Somerville, Mass. App. filed Aug. 30, 1897. In a vessel having a propelling mechanism and a steering mechanism operated by power generated or stored within the vessel, two step-by-step devices carried by the vessel for controlling said mechanisms and operated by the making and breaking of two circuits at a distance from the vessel.

619,028. ELECTROCHRONOGRAPH; C. W. Thompson, of La Crosse, Wis. App. filed June 27, 1898. The combination with a clock-movement, of a notched wheel attached to the hour-hand arbor thereof, a pin carried thereby, the toothed wheels adapted to be operated by the said wheel by means of the said notch and pin carried there, a hallow arbor carrying an index-hand and index, and an electromagnet adapted to set the operative mechanism in motion when a current is flowing through the said magnet, and to stop the operative mechanism when the current ceases to flow through the said electromagnet, substantially as described.

619,034. SWITCH-HANDLE FOR TELEPHONE CALLS; O. R. Cline, of El Dorado, Kan. App. filed August 8, 1898. An operating crank for magneto-calls comprising a bushing, a contact-sleeve insulated from and joined rigidly to said bushing, a crank mounted movably on the bushing, and a circuit-contact in engagement with the sleeve, substantially as described.

619,038. AUTOMATIC ELECTRIC SIGNAL FOR RAILWAY-CROSSINGS; U. J. Fry, of Milwaukee, Wis. App. filed Sept. 26, 1898. In electric signal apparatus for the protection of crossings or danger-points on railways, the combination of a local circuit including a signal and source of current, a primary switch having a normal tendency to close, a secondary switch having a normal tendency to open, a primary magnet arranged to open the primary switch, a secondary magnet arranged to close the secondary switch, a detent normally holding the primary switch open, a releasing magnet arranged when energized to disengage the detent from the primary switch, a circuit adapted to be closed at a distant point by an approaching train and including the primary switch-arm, the detent, the releasing-magnet and a source of current and another circuit adapted to be subsequently closed by the passing train at or near the point to be protected, and including the primary and secondary magnets and a source of current.

619,080. TROLLEY POLE AND WHEEL; F. Kramer, of Blythedale, Pa. App. filed May 11, 1898. In a trolley, the combination of a harp having suitably journaled therein a trolley-wheel, guides, journaled on each side of said trolley-wheel on the inner face of the harp, spring-actuated arms pivoted at the centre to said guides which are adapted to retain the wheel in contact with the wire and a series of lever-and-rod connections connected to said guides for keeping the spring-actuated arms in a vertical position when the trolley is either depressed or elevated, substantially as described.

619,090. ELECTRIC-ARC LAMP; A. Schweitzer, of Allegheny, Pa. App. filed June 7, 1898. In an arc lamp, the combination of a central column or support having a plate securerd thereto, an electromagnet and dash-pot mounted on said plate, a casing surrounding the core of said magnet having irregular slots formed therein, a rod pivotally secured to said dash-pot, and connected to the upper-carbon holder whereby a steady feed of the upper carbon to the lower carbon is attained, substantially as described.

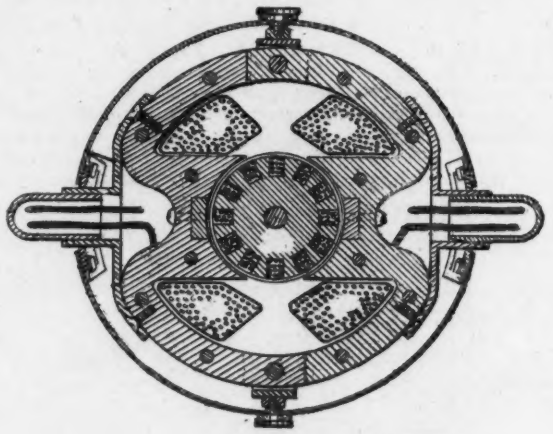
619,091. AUTOMATIC MAGNETIC CIRCUIT-BREAKER; W. M. Scott, of Philadelphia, Pa. App. filed Jan. 28, 1898. In an automatic magnetic circuit-breaker, having fixed and movable contacts, in combination with means for effecting the separation of the movable contacts from the fixed contacts, means of restraining the operation for the said separating means until actuated to permit the same, means for actuating the restraining means, and an electromagnet and armature for controlling said actuating means during predetermined flow of current through the magnet, and automatic means for cutting out of circuit the coil of the electromagnet after the actuation of the restraining means, and before the separation of the fixed and movable contacts.

619,157. COMPOSITE SIGNALING AND TRANSMISSION SYSTEM; S. D. Field, of Stockbridge, Mass. App. filed Dec. 24, 1897. A composite system of one telephonic circuit and three telegraphic circuits, formed of two main conductors, the said conductors serving severally as the line conductors of two of the telegraphic circuits, being connected in parallel to constitute the third telegraphic circuit, and being connected in series to constitute the metallic telephone-circuit, substantially as described.

619,164. TROLLEY-POLE; P. H. Gilbert, of Hazleton, Pa. App. filed April 7, 1896. The combination with the trolley-pole and the trolley-wheel having flanges flared outwardly, of the springs secured in the fork of the pole and bearing against the outer faces of said flanges, a short pole forked at its end and adapted, to be secured at the other end to the fork of a two-part clamp adjustably secured to the trolley-pole and a connection between the short pole and the fork of the clamp to allow a limited pivotal movement of the said short pole, and the ice-clearing wheel having ribs, substantially as described.

619,213. TROLLEY-CATCHER; C. H. Ocumpaugh, of Rochester, N. Y. App. filed Nov. 26, 1897. A trolley-controller consisting of a frame carrying a spring-containing drum, two springs situated around an arbor within the drum and each connected to the drum and frame and a dividing-partition between them, said partition being loosely connected to the spring-arbor, substantially as described.

619,217. ELECTRIC MOTOR; O. H. Pieper and A. F. Pieper, of Rochester, N. Y. App. filed March 21, 1898. The combination with a motor, of a casing-section, the fingers thereon, and the segmental washers held by the fingers and adapted to co-operate with the motor.



No. 619,217.—Electric Motor.

619,240. TOLL COUNTER OR REGISTER FOR TELEPHONIC CIRCUITS; G. K. Thompson, of Malden, Mass. App. filed June 21, 1898. In a telephone call signal-registering apparatus, the combination of two electromagnets, one of which is provided with an armature carrying or adapted to operate a pawl or escapement, the second being relatively sluggish in operation and having an armature adapted to lock the first armature while both armatures are in their unattracted position; with a counting mechanism provided with a ratchet-wheel arranged to be rotated by said pawl or escapement, and one or more dials with points impelled by the said ratchet-wheel.